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NITRE GUANO

NATURAL RESOURCES
OF
Boone and Marion Counties
ARKANSAS.

SILVER ZINC COPPER ANTIMONY LEAD ONYX COBALT KAOLIN MANGANESE ALABASTER NICKEL GYPSUM IRON STRONTIA

CLIMATE, SOIL, WATER, TIMBER, MEDICINAL PLANTS, ETC., ETC.—MINERALS OF COMMERCIAL IMPORTANCE.—THEIR OCCURRENCE IN QUANTITY AND QUALITY.

OPPORTUNITIES FOR NEW INDUSTRIES AND INVESTMENTS.

A HAND-BOOK FOR THE CAPITALIST, PROSPECTOR AND MINER.

By W. Albert Chapman, M. E.,

Assayer and Mine Reporter, Member of the Davenport Academy of Natural Sciences, Member of the American Association for the Advancement of Sciences. Correspondent Arkansas Press.

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TABLE OF CONTENTS:

A Plea for the Business of Mining. Mineral Deposits of Arkansas. Chemistry of the Creative Period. Geology. Ore Deposits—Forms of, Character of. Genesis of Silver, Copper, Lead, Zinc, Iron, Manganese, Nitre, Guano, Alabaster, Marbles, Onyx, Polishing Powders—Mode of Occurences, Utilization. Forms of Legal Papers. Tables of Specific Gravity. Geogony of Dykes, Veins, Fissures, Etc. Prospecting, Tools, and much other interesting matter of importance to mining men.

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PRICE 50 CENTS.

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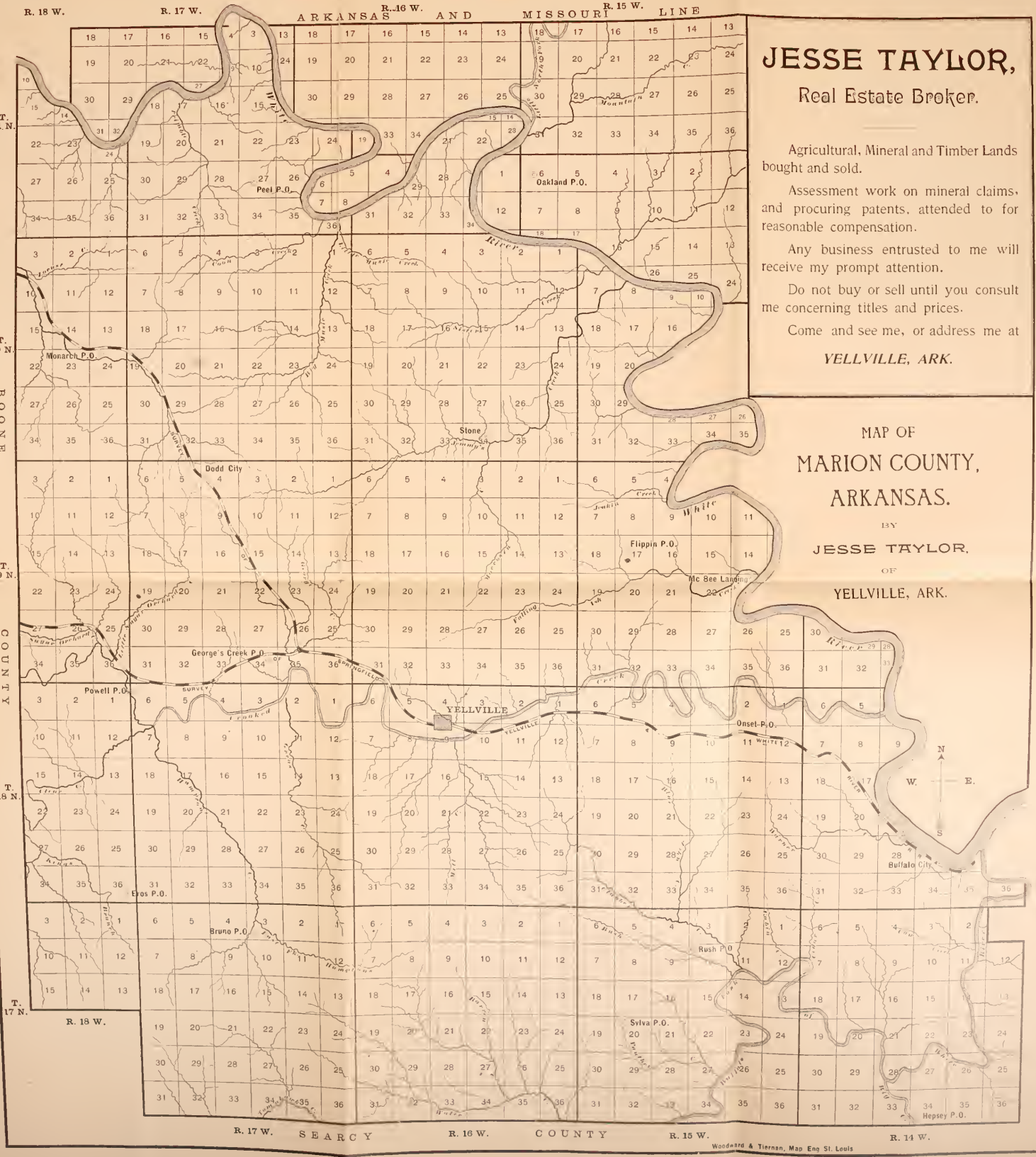
STATE OF ARKANSAS, }
COUNTY OF PULASKI, } ss.

The Brown Printing Company hereby certifies to the printing of 1500 copies of this issue of the pamphlet "Natural Resources of Boone and Marion Counties."

[Signed] BROWN PRINTING CO.,
By C. H. KENNEDY, *Secretary*.

LITTLE ROCK, ARK., June 15, 1894



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MAP OF

MARION COUNTY, ARKANSAS.

BY

JESSE TAYLOR,

OF

YELLVILLE, ARK.

INDEX.

Page.

Introductory 1
Comments on 1st edition 2
Climate 3
Topography 3
Soils 3
Waters 4
Medicinal plants 4
Forest growths 5
Products of the soil 5
Fruits 5
Building Materials :
quotations of 6
Stock raising 6
Game 6
Sporting 6
Fishing 6
Lands :
quotations of 6
vacant United States lands 7
stone lands 7
mineral lands 7
Industrial Opportunities :
enterprises 7
labor 8
fuel 8
cost of living 8
market quotations 8
wealth of Harrison 8
wealth of Boone County 8
wealth of Yellville 9
wealth of Marion County 10
schools, churches 10
Plea for the business of mining 11
Economic geology 15
What gives lands value 15
Resources of Arkansas 17

Arkansas Gem Stones:
list of 21
State Geological Reports:
descriptive outline 23
pantography 23
White River 25
Buffalo River 26
ore barges 26
ore sacks 26
Cost of transportation:
by barge 27
by steamer 27
Cosmogony:
chemistry of the creative period 27
chemistry of ore deposits 31
formation of ore deposits 33
ore bearing strata 33
chemical composition of ore bearing strata 34
Geology:
geology of region 37
topography of region 39
chemical action in ore deposits 40
character of ore deposits 41
classes of ore deposits 43
Types of Kinds:
Full Moon 44
Big Buffalo 44
Morning Star 44
Leader 44
Grey Eagle 44
Crown Point 44
Cost of mining 45
Cost of transportation 45
Lead Ore Deposits:
Short Mountain 46
Aluminum:
genesis, ores, uses, reduction 46
Asphaltum 51
Antimony:
genesis, uses, reduction, ores 51
Copper:
genesis, ores, uses, reduction 55
Cobalt:
genesis, ores, reduction, uses 58

Cadmium :
genesis, ores, reduction, uses 59
Gold :
genesis, ores, uses, reduction 60
Iron :
genesis, ores, uses, reduction 62
Lead :
genesis, ores, uses, reduction 65
Manganese :
genesis, ores, uses, reduction 67
Nickel :
genesis, ores, uses, reduction 68
Silver :
genesis, ores, reduction, uses 70
Zinc :
genesis, ores, reduction, uses 72
Strontia :
uses 84
Barium :
uses 84
Calcite :
uses 84
Lithographic stone 85
Hydraulic limestone 85
Tripoli :
its uses 85
Silica :
its uses 86
Alabaster :
its uses 86
Marble :
its uses 86
Kaolin :
its uses 51, 87
Talc :
its uses 87
Quartz :
its uses 87
Onyx :
its uses 87
Jasper :
its uses 88
Flint :
its uses 88

Nitre Earths:
manufacture ... 88
uses, etc ... 88
cost of plant ... 89
Pearl Fisheries:
value ... 90
where found ... 90
Pyrites of Iron:
uses ... 90
Sulphuric acid ... 90
Copperas paints ... 90
Guano:
uses, fertilizer, basis of ammonia, manufacture, value ... 90
Mineral paints ... 90
Smelting of ores ... 91
Ore crushers ... 91
Local markets for ores ... 91
Railroads contemplated ... 91
Railroad points ... 91
Progress in metallurgy ... 92
Geogony of dykes, veins and fissures ... 93
Rocks encountered by miners ... 99
Prospecting:
equipment for ... 101
Occurrence of ore deposits ... 102
Methods of occurrences of ores ... 102
Cubic feet removed in excavating ... 102
Tools for force of ten men ... 103
Specific gravity of rocks, ores and earths ... 103
Legal Forms:
miner's lien ... 104
power of attorney ... 105
option ... 105
quit-claim deed ... 106
location notice ... 106
acknowledgment ... 107
escrow agreement ... 107
proof of labor ... 108
lease ... 108

INTRODUCTORY.

The pamphlet of the first edition, consisting of about thirty-five pages, was the result of a wide-spread demand for accurate and reliable information relative to the mineral resources of this region; and of the opportunities for investment then available. That this condition was fully and satisfactorily met, was evinced by the ready sale of the edition, and further demonstrated by the hearty approval of scientific and professional men of large practical experience in all pertaining to mining, and fully conversant with our resources in their then state of development. The continued and increasing demand for information, recent discoveries, satisfactory development, etc., has necessitated the printing of a second edition of the pamphlet, to which much additional matter has been added, increasing threefold its original size.

Inquiries from farmers, stockmen, mechanics and others seeking homes and business locations, has induced me to include matter "which, while not without interest to the mining man," is of especial interest to the classes named. Such information is necessarily brief and it is hoped explicit. In its compilation, I have been materially aided by those gentlemen whose names appear in connection with the material supplied by them. Hoping that this little book may prove a factor in the speedy development of the wonderful resources of this region, and the open sesame to prosperity and wealth for you and our people, I am, Yours truly,

AUTHOR.

WHAT WAS SAID OF THE FIRST EDITION.

GEOLOGICAL SURVEY OF ARKANSAS,

John C. Branner, State Geologist.

LITTLE ROCK, ARK., Oct. 10, 1889.

Prof. W. Albert Chapman:

MY DEAR SIR—I beg to acknowledge and thank you for a copy of your very interesting and valuable little publication, "The Natural Resources of Boone and Marion Counties." You are doing a good work for the northern part of the State and I hope that the people will appreciate your efforts.

Very truly yours,

J. C. BRANNER.

We have before us a pamphlet on "The Natural Resources of Boone and Marion Counties," by Prof. W. Albert Chapman, M. E., assayer and reporter of mines. It is valuable and remarkable as being the first scientific description of the resources of this region that has been written for popular use. Prof. Chapman covers the whole range of subjects that are now drawing the attention of capitalists to this region, and brings the opinions and impressions of the many to the test of scientific analysis. A copy of this pamphlet should be in the hands of every man seeking profitable investments. To mining men it is invaluable. LAWRENCE CARROLL, Editor Taney City Times (in Review).

Your pamphlet "Natural Resources of Boone and Marion Counties" is a valuable and desirable contribution to mining literature. The theory, you advance of the formation of the zinc and lead ore deposits, is very interesting, as it gives light on obscure features associated with such. S. JOHNSON, M. E., Springfield, Mo.

I am very much pleased with it. Your theory of the formation of the ore deposits is in full accord with my observations in the field. Investers guided by its teachings will hardly make unprofit-able investments. C. F. DRAKE, C. E., M. E.,Werner, Idaho.

The pamphlet "Natural Resources of Boone and Marion Counties" is not only an authoritative and reliable guide to investers in mineral lands, but also a miners and prospectors' hand-book of great value. NORTH ARKANSAS HERALD.

In the absence of a State geological report, your little pamphlet. fills a necessity long felt. The results of my practical experience are in keeping with its statements. E. C. COOK, M. E., Recorder of the El Dorado Mining District.

NATURAL RESOURCES OF BOONE AND MARION COUNTIES.

CLIMATE.

The climate of Northern Arkansas is mild and salubrious. The long summers are not attended by periods of excessive heat; sunstrokes and prostration from heat being unknown. The rains are generally seasonable, propitious, and not characterized by violent storms. The winter months are remarkable for the long periods of warm, sunshiny weather, the light snowfall, and the absence of severe cold; there being but few successive days in which laborers require or make use of the protection of a coat. Potatoes are frequently, without detriment, let remain in the ground during winter. Peas and potatoes are usually planted in February. Ice seldom forms of such thickness as to permit cutting and storing.

TOPOGRAPHY.

The surface of the country is rough and rugged. Mountainous ridges, rising to an altitude of five hundred feet, and continuous for many miles, give place upon their summits to extensive tracts of more or less level lands; and in the broadening and mergence of the valleys, prairies "of greater or lesser extent" are formed.

SOILS.

The diversity in the character of the soil is very great and strongly marked; the variation in kind being due to position, method of formation, and the source of the component parts. Each kind, is best adapted to the growth of certain plants, and in determining the adaptability of the soil the agricultural produce of any will be most materially increased. The valleys of the rivers and larger streams are extremely fertile and produce large yields of various crops. The uplands, while not produc-

ing so well as the lowlands, are adapted to the growing of a greater diversity of crops, and for many purposes are preferable to the more fertile lands. Little attention is paid to the fertilization of land.

WATERS.

The region is well watered by numerous streams, having their origin in springs, a number of which are of such size as to furnish an abundance of power for large manufacturing plants. The most noted springs are the "Guthrie Spring," on Rush Creek; the "Chapman Spring," in Chapman Hollow; the "Blackwell Spring," on Sugar Loaf, and the "Elixir Spring," on Sugar Orchard, Boone county; this last being widely known and highly esteemed for its medicinal virtues. The spring waters are clear, cold and palatable, and vary in their degree of hardness, in proportion to their contents of carbonate or sulphate of lime. In the absence of springs water is had at depths varying from twenty to ninety feet.

MEDICINAL PLANTS.

1. Burdock (arclinum lappa).
2. Black Cohosh (cimicifuga racemosa).
3. Bloodroot (sanguinaria canadensis).
4. Blackberry (rubens villosa).
5. Balmony (chlone glabra).
6. Boneset (eupalorium perfoliatum).
7. Blackroot (leptandra virginica).
8. Bugle weed (lycopus virginiacus).
9. Crane's bill (geranium maculatium).
10. Belladonna (atropia belladonna).
11. Catnip (nepeta cataria).
12. Dogwood (cornus florida).
13. Dogfennel (marita cotula).
14. Gravel plant (epigea repans).
15. Golden seal (hydrastis canadensis).
16. Hops (humulus lupulus).
17. Henbane (hyoscyamus neger).
18. Indigo plant (baptisa tenclosia).
19. Mandrake (podophylluma pellatum).
20. Lobelia (lobelia inflata).
21. Poke (phytolacca decandria).
22. Poison parsley (conium maculatum).
23. Peppermint (mentha peperita).
24. Pleurisy root (asclipias tuberosa).
25. Pennyroyal (hedsoma puligioides).
26. Queen of the meadow (eupalorium purpurea).
27. Pink root (spigelia mariandiia).
28. Sage (silvia officinalis).
29. Sweet elder (sambuccus canadensis).
30. Spearmint (mentha varidis).
31. Tansy (tanacetum vulgare).
32. Tag alder (alnus rubra).
33. Valerian (valeriana officinalis).
34. Virginia snake root (aristolochia tuberosa).
35. Witch hazel (hamomalis virginiana).
36. Wild yam (dioscaria villosa).
37. Willow (silex alba).
38. Wafer ash (pletea trifoliata).
39. Yellow dock (rumex crispus).
40. Yellow lady's slipper (cypripedium rubaccus).
41. Yellow jasmine (geleminum sempus).
42. Ginseng (p. ginseng).
43. Smartweed.

FOREST GROWTHS.

Cucumber tree (magnolia acuminata, Linn.).
Basswood (tilia amcrica. Linn.).
Buckeye (æsculus glabra, Harvey).
Sumach (rhus copallina, Linn.).
Honey locust (gleditschia tricanthar, Linn.).
Black gum (nyssa sylvatica, Marshall).
Persimmon (diospyras virginiana, Linn.).
Elm (ulmus alata, Michaux).
Mulberry (morus rubra, Linn.).
Hickories (various species).
White oak (quercus albus, Linn.).
Overcup oak (quercus lyreta, Walter).
Red, Spanish oaks. and other species to me unknown.
Willow (silex alba).
Cottonwood.
Cedar.
Cherry.
Pawpaw (asimina trilobi, Dunal).
Prickly ash (xanthoxylum clavaterculis, Linn.).
Maple (acer rubrum, Linn.).
Plum (prunis americana, Marshall).
Dogwood (cornus florida, Linn.).
Blue ash (fraxinus quadrangulata, Mich.).
White ash (fraxinus americana, Linn.).
White elm (ulmus americana, Linn.).
Sycamore (platanus occidentalis, Linn.).
Walnut (juglans nigra, Linn.).
Water oak (quercus aquatica, Walter).
Pin oak (quercus palustris, Du Roi).
Cypress (taxidium disticlum, Richard).
Pine (pinus mitus, Michaux).
Chinquapin.

NOTE.—With the exception of walnut and cedar, and such timbers as are destroyed in clearing, milling, etc., the forests are intact, and offer a basis for several profitable industries. Other species occur, but are unknown to me.

PRODUCTS OF THE SOIL.

Systematic farming is practically confined to the growing of the staples, cotton and corn, to the detriment of the country. Wheat, oats, rye, potatoes, sorghum, sweet potatoes and tobacco are grown to lesser extent, but with gradually increasing acreage. Vegetables of all varieties grow to perfection, yielding large crops.

FRUITS.

The soils of the uplands, both in character and position, are most peculiarly adapted to the production of fruit. The climate still further increases the adaptability of the region to this purpose. The superior character of the region, as a producer of fruit, is demonstrated by the character of its productions, which are of delicious flavor, large size and great beauty. In their excellence they surpass that of the productions of all other fruit-growing regions, as witness, the awards of the New Orleans Exposition and the World's Fair. The yield is excessive, many large trees being broken asunder by the

weight of their fruit. All fruits of the temperate, and numbers of those of a semi-tropical climate, thrive in great perfection with but little care and attention.

NOTE.—To those unable to engage in arduous labor, and possess but little capital, a field "unlimited in its possibilities" is opened up.

BUILDING MATERIALS.

Marbles, onyx, lime and sandstone offer, for building purposes, for the mere cost of quarrying. Material for lime and cement is equally abundant. Log houses (of one to four rooms), cosy and comfortable, can be erected at a cost of labor, viz.: $20 to $100.

Pine lumber is cheap and at hand, and quoted at—

First-class	$12 50 per m.
Second-class	10 00 per m.
Third-class	8 00 per m.

STOCK RAISING.

The climate, soil, range and topography of the country renders it in every way adapted to the successful raising of mules, horses, cattle, sheep and hogs. Such industry is not dependent upon near transportation facilities, and is as yet, neglected.

GAME; SPORTING.

While in this respect, not equal to some other regions, the country still contains a sufficiency of game to afford good sport. The list embraces the following: Deer, raccoon, opossum, rabbits, squirrels, ducks, geese and quail. Foxes and wild-cats are numerous, and a few wolves exist in remote districts.

FISHING.

The rivers and larger streams are well stocked with catfish, buffalo, red-horse, suckers, trout, bass, skip-jacks, chubs, dace, eels and gars, and in season furnish good sport.

LANDS.

Improved bottom lands may be purchased at from $20 to $30 per acre.
Unimproved bottom lands may be purchased at from $5 to $15 per acre.
Improved upland lands may be purchased at from $3.50 to $10 per acre.
Unimproved upland lands may be purchased at from $2 to $5 per acre.

VACANT UNITED STATES LANDS.

Such, where not mineral lands can be acquired by homestead entry of 160 acres, at a cost of $14 for lands outside railroad limits, or those within such limits, $18, and actual residence for five years; or, if desired, after an actual residence of fourteen months, the time may be commuted and patent acquired by the payment of $1.25 per acre.

United States lands, of value only for the stone, are purchased outright at $1.25 per acre, proof being required as to the valueless character of the land for agricultural and mining purposes.

United States mineral lands can only be acquired by compliance with the United States mining laws, which require (after location and recording) an annual expenditure of labor upon such land until patent issues. So long as the law is complied with, the location paper has the same status as a warrantee deed.

BUSINESS AND INDUSTRIAL OPPORTUNITIES.

The resources of the country offers a sound and safe basis for the founding of numerous profitable industries; the capital requisite to such purpose being, to a great extent, determined by the proposed magnitude of the industry. The products are staple in character, and meet with a ready sale in open market. Transportation to market is had by means of White River. More or less "local" assistance can be had in the founding of any of the following

ENTERPRISES:

The manufacture of cedar woodware, staves, hoops, etc., wagon material.

The smelting of copper, lead and zinc ores.

The manufacture of lead and zinc white, sulphates of copper and iron, nitrate of strontia, nitrate of potash, sulphuric acid, sulphur and mineral paints.

The cutting of onyx and marble.

The mining and shipment of tripoli and guano.

The manufacture of woolen and cotton goods.

LABOR

Ranges in price from 75 cents to $1.50 *per diem* (without board).

FUEL.

Wood, 75 cents to $2 per cord. Charcoal, 5 to 8 cents per bushel.

THE COST OF LIVING

May be adduced by a comparison of the following local market quotations with those of other localities:

Yellville market, reported by H. A. Young, "merchant:"

Coffee, green, 4 pounds for $1; Arbuckles, roasted, 3⅓ pounds for $1; sugar, white, 13 pounds for $1; coffee A, 12½ pounds for $1; salt, per bushel, 75 cents; per barrel, $2.80; sorghum, per gallon, 40 cents; per barrel lots, per gallon, 35 cents; flour, "Patent Roller," $2 per 100 pounds; meal, per bushel, 50 cents; pork, per pound, 5 cents; butter, per pound, 10 to 12½ cents; eggs, per dozen, 5 to 15 cents; potatoes, per bushel, 50 cents; sweet, per bushel, 50 cents; beans, "navy," per bushel, $1.50 peas, per bushel, 75 cents to $1; cabbage, per head, 3 to 4 pounds, 5 cents; turnips, per bushel, 25 to 30 cents; coal oil, per gallon, 25 cents; chickens, 10 to 12½ cents each, weight, 2 to 5 pounds; milch cows, $10; extra choice, $20; horses, $40 to $75. Week ending January 7, 1894.

WEALTH OF BOONE AND MARION COUNTIES—COUNTY SEATS.

HARRISON

The county seat of Boone County is most delightfully situated in a well-watered region, rich, fertile and well timbered, abounding in resources requisite to successful farming, in addition to those, which, if utilized, give assurance of an ever increasing market for the reception of agricultural products. Such are in the development of the mineral resources adjacent, and the founding of factories, and other industrial enterprises, to which her location peculiarly adapts her. The population of 1800 souls possess wealth aggregating $200,000, which is em-

bodied in well-built structures of brick and stone, attractive dwellings, banking interests and valuable stocks of merchandise of such class and kinds as is necessary to the supplying of the requirements of a well-to-do, prosperous and progressive people, distributed over an extensive territory, for which Harrison is the collective and distributing center, her volume of trade averaging $700,000 per annum. Schools of high grade afford unrivaled opportunities to those desirous of acquiring an education. The spiritual welfare of the community is looked after jointly by Methodist, Baptist, Presbyterian and Christian divines. Each denomination is possessed of valuable property. The educational interests are represented by three ably edited monthly journals. The welfare and interests of the community are guarded and fostered by the Boone *Banner*, A. C. Hull, editor, and the Harrison *Times*, T. J. Newman, editor, either of whom will, with pleasure, aid home-seekers or investers. The location of the U. S. land office at this point is most advantageous, as Harrison is of easy access from all of the thirteen counties under the jurisdiction of that office. The wealth of Boone County is placed at $1,500,000. The annual exports of choice fruit, agricultural products and live stock aggregate $300,000. The value of imports during the same period averaged $150,000. Numbers of lesser but thriving, prosperous villages are within the limits of Boone County. At one such, Lead Hill, located in the central portion of the lead region, is an extensive and well-equipped foundry and machine shop. A large modern roller flouring mill is in operation at this point.

YELLVILLE, COUNTY SEAT OF MARION COUNTY.

Yellville, a rather pretty village of 450 souls, is situated in a rincon or break-off, in the valley of Crooked Creek. Nearly centrally located, it at present is the center of the most extensive and active developments of mineral properties, and forms the point of distribution of supplies for an extensive region, rich in mineral and agricultural resources. The public buildings are of brick and stone, well and substantially built. A number of elegant dwellings are seen. Iron and marble enter into the

structure of the Layton block. Large stocks of merchandise are carried by the various merchants. The Bank of Yellville affords every facility common to banking. The aggregate wealth is $1,500,000. The educational advantages afforded by the Yellville Institute are of a superior order. The Methodist and Presbyterian denominations possess valuable church property, which other denominations are permitted to make use of in their worship. Desirably located as an industrial town, the manufactures of Yellville are as yet confined to the output of a roller mill of a daily capacity of forty barrels. The *Mountain Echo* ably represents the interests of the people. Its growth has been rapid and assured.

DODD CITY.

This little burgh is already characterized by vim, vigor and rapid growth. Topographical features certainly determine its future as a railroad town. The pinery, mineral resources and desirable location give assurance of the development of an industrial town at this place. The *Marion County Enterprise* is the energetic advocate of the interests of this town, named in honor of its venerable founder, Dr. H. S. Dodd. The aggregate wealth of Marion County is given at $1,500,000. The population numbers 2,500, by whom a school fund of $1655 is provided by special tax. The county is prohibition. The deposits of zinc exceed in number and extent those of all other counties in the State. The exports are zinc ores and agricultural products.

In every district in both counties well-supported and patronized schools and churches are alike common. An inspection of our statute books and the records of each county court will demonstrate that the people of this region are in morality and high principles the equals of those of any State. A portion of our people, compelled to face the stern realities of life from their early youth, spent in the desolation and wreckage of the civil war, may be deficient in the usages and vernacular of refined society, but under the rough exterior is hidden a

heart of gold, which manifests its presence in an innate refinement, hospitallity and earnest good will to all.

For the facts relative to population, wealth, etc., of Boone and Marion Counties, I am indebted to Mr. H. C. Hull, of Boone County, and J. W. Black, County Clerk of Marion County. With pleasure I here acknowledge the obligation.

The following extract from a letter of the talented State Geologist to the author, under date of December 25, 1893, is certainly of interest and unalloyed value:

"Boone and Marion Counties are in one of the most attractive portions of the State of Arkansas. The healthful climate, the abundant springs, the charming scenery, the fertile soil, the hospitality and warm heartedness of the people, when taken in connection with the natural resources, make that section of the State a delightful place for residence, and one of which it is difficult to speak in too high terms. Yours truly,

"J. C. BRANNER.

"Palo Alto, Cal., Dec. 25, 1893."

COLLECTIONS OF ARKANSAS MINERALS.

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Practical instructions given in assaying, analytical and technical chemistry, blow-pipe analysis, determinative mineralogy, mining geology, electro-metallurgy, construction and care of batteries.

W. ALBERT CHAPMAN,
Mining Engineer, Assayer and Analyst.

A PLEA FOR THE BUSINESS OF MINING.

The mining industry is by many regarded as being speculative in its nature, and abounding in peculiar risks and dangers, which threaten the invester from every side. Such misconception of facts has its origin in losses accruing to the purchasers of worthless stocks, of valueless prospects; or in those resulting from the unreasoning and unnatural fluctuations in value of the stocks of dividend-paying mines. While founded

upon, and rendered possible by the demonstrative profits of legitimate mining, such speculative features are antagonistic to, and in no wise associates of that industry, they bearing the same relation to actual mining, as does the dealing in futures to the growing of wheat or cotton. Mining, presupposes the possession of a natural deposit of a mineral substance, which has within itself an inherent utility applicable in the economy of life, whereby the value is fixed and the demand for the substance assured. The removal from a deposit of such material constitutes the business of mining, and fixes the locus of the risks, peculiar to the industry, and renders self-evident the fact, that such risks are confined to the uncertainties of extent and continuance in kind and quality of the ores of an undeveloped deposit, and cease with the development of the deposit. The probability of a cashier absconding with the assets of a bank can be accounted a fixed liability of such institution, with the same degree of reason and justness as attributing to mining those risks due to mismanagement, ignorance and folly. The status of the mining industry as a desirable field for investment, is best demonstrated by a comparison of it with that of some other industry regarded as a safe and satisfactory method of gaining a livelihood. Agriculture, is such, yet here attends uncertainty in the planting of the seed, its germination and growth. Myriads of enemies watch the maturing of the crop, storms and drouths sweep over region after region, and the product when garnered is still the objective point of destructive agencies. From the casting of the seed to the gathering of its product, agencies over which man has no control, holds potent sway. Danger, disaster and destruction stand ward over every other industry awaiting to destroy the product, however carefully guarded. Merchandising is proverbially uncertain; manufacturing is hampered by fluctuations of supply and demand, while agriculture in numberless instances affords but the scantiest of livings. As in these so in other industries. The capital, practical knowledge, energy and economy requisite to the attainment of success in these industries, if applied to mining, can know no failure, as the mining industry is the

basis upon which rests the entire social system. The progress of the human race in intelligence, refinement and wealth is dependent upon the advancement attained in the use of the products of the mines. The first arrow-head forged by Tubal Cain was the procuresor of the Greek javelin, the Roman spear, the Damascus blade, the plow, the engine, the press and the roadways of thought which bind together the nations of the earth.

The Phœnician fire, kindled on the shore of the sea, gave birth to dainty forms in glass, and revealed to us the mysteries and wonders of space.

Gold and silver, in the facility of their working and unchangeable characters, early fixed their value and adaptability to use as representatives of values and ready means of exchange. The mining of copper made possible the construction of the dynamo, the throbs of whose mighty pulsations are now felt in the arteries of industry. The utilization of coal rendered possible the centralization of industries, wealth and population, and finds expression in the building of mighty cities which in wealth and grandeur rival the glories of ancient kingdoms. And in the utilization of the metal aluminum is the dawning of a new era, fraught with startling innovations and the embodiment of now seemingly visionary ideas into tangible forms. The availability of the products of inorganic nature to utilization in the arts and economies of life is the foundation of the mining industry. Creative features have neither part nor lot in it; it is simply the utilization of pre-existent wealth. As population increases new wants and necessities arise, the gratification of which can only accrue from mining, and determines that the increase of the one is in direct ratio with the other. Other fields of productiveness are limited; not so this, the garners were stored and made accessible to man by the Creator, whose infinite wisdom has prepared for all time the essentials of man's continued existence, and to each accession of knowledge by man, reveals the essential then requisite.

COME, LET US REASON TOGETHER.

Does there anywhere exist an industry, a demand for the products of which, is so sure and stable, fixed, as it is by the laws of necessity? Is it not patent that such law must needs become more direct in its bearing upon demand, more potent in effecting the reception of the products of the mine with the lapse of time? Is not this assurance of the absorption of products a part of the sternest law that directs the action of man? How, then, can the acquisition of ownership to land, containing workable deposits of minerals or the simple extraction of such ores, be productive of loss? The absurdity of such result being inherent to either act, is self-evident. The assertion that disaster is an invariable associate of the industry, is no less absurd when compared with the demonstrative profits and achievements of the mining industry.

In 1845 the West, bordered upon the Mississippi River; beyond was a *terra incognita*. The discovery of gold in California in '49, swept the western border to the sea, and gave to the world in one year gold equal in value to the then world's supply. With resistless and lightning-like rapidity, the industry gave birth to towns, cities and states. Railroads and steamship lines, vast streams of metallic wealth, flowed from the fastnesses of the Rocky Mountains eastward, and in one generation carried the republic into the foremost rank of nations. From 1879 to 1889, a period of ten years, the reported mines of Colorado produced gold, silver, lead and copper valued at $230,000,000. During that period the voting population averaged about 60,000, one-third of whom, it is estimated, was engaged in prospecting, mining, milling and smelting. Assuming that each of these men has received $2.50 per day for ten years, the sum of $156,000,000 was required to meet the pay-roll, leaving a credit balance of $74,000,000, or $7,400,000 per annum, to which sum at least $2,000,000 should be added as the earnings of individuals engaged in enterprises they would not report. The writer, during a portion of this period, realized large profits by extracting the silver and gold from zinc ores, then regarded as valueless. Others realized

large returns from singly working properties of which little was known. Hardly a thousand of the mines, which are rapidly enriching their owners, are known to the public. In this industry, as in all others, profit is the main object, and where this cannot be attained with a reasonable certainty and within a reasonable time, the further expenditure of labor and money becomes a questionable matter outside of legitimate business. An inspection of the list of dividends declared and paid by mines, capitalized at hundreds of thousands, will certainly prove productive of astonishment to those who do not know that such mines "often" do not exceed twenty acres in extent, and that but a very limited portion of such limited acreage is productive of ores, and give them new ideas relative to the value of land and the mining industry.

ECONOMIC GEOLOGY AND THE VALUE OF LANDS.

The value of land, fixed by its adaptability to the purpose of agriculture, is often exceeded a thousand-fold by that which accrues to it through the occurrence of deposits of minerals the utility of which renders them applicable in the economic purposes of life. Such minerals are termed economic minerals and by geologists are classed as follows:

Agricultural minerals.—Building stones, stones for decorative purposes, sculpture, mortars, cements, concretes, etc.

Minerals used for the production of heat and light.—Coal, lignite, bituminous shales, petroleum, natural gas, strontia lime, magnesia.

Minerals used in pottery.—Kaolin, fire clay, terra cotta clay, brick clay, infusorial earth, meerschaum quartz, feldspar, potters' clay, pigmatite, salt, borax.

Minerals used in glass making, mettallurgy and similar arts.—Qnartz, sand, potash, soda, borax, lime and metallic oxides.

Refractory, or fire-resisting materials.—Bauxite, fire clays, soapstone (steatite), kaolin, graphite, asbestos, sandstones.

Minerals used for grinding, polishing, etc.—Millstones, sandstones, grit, emory, corundum, tripoli, infusorial earth, rottenstone, slatestone, whetstone, novaculite, oilstone.

Minerals used as pigments and coloring materials.—Ochres, ambers, sienna, baryta, calcite, hematite, cobalt, chrome-iron, realgar, orpiment, cinnabar and other metallic oxides.

Salts and saline earths.—Salt, natron, trona, glauberite, borax, cryolite, nitrates of soda and potash, epsomite, alum slates, copperas, bluestone, sulphate of zinc.

Minerals used in pyrotechnics.—Sulphur, sulphide of iron, of arsenic, of copper, of zinc, of antimony, soda, potash, and their carbonates and nitrates, clays.

Ores of metals.—Aluminum, antimony, arsenic, barium, bismuth, cadmium, chromium, cobalt, nickel, copper, gold, iron, lead, magnesium, manganese, mercury, silver, tellurium, tin, tungsten, uranium, vanadium, zinc.

Native metals.—Gold, platinum, palladium, iridium, silver, copper, mercury.

Gems and precious stones.—Diamonds, rubies, emerald, sapphire, torquoise, topaz, beryl, zircon, lapis-lazuli, moonstone, sunstone, cat-and-tiger eyes, labordorite, garnet, pyrope, amethyst, carbuncle, alamandine, tourmelane, chalcedony, agate, onyx, opal, jasper, malachite.

Mineral springs.—Hot and cold springs, chalybeate, sulphur, carbonated, alkaline, lime and magnesian waters.

Any of the enumerated minerals may be found on lands where their presence is not suspected. Their presence offers a basis for the establishment of various manufacturing industries and mining operations of assured success, where accessible; otherwise (in the absence of transportation) choice investments, the near future will enhance in value wherever located. If you have capital to invest in the establishment of safe and profitable industries, "founded upon the utilization of such deposits," or if you have skill and experience in rendering the products of such deposits marketable, it is to your advantage to confer with me.

THE MINERAL RESOURCES OF ARKANSAS.

This list of Arkansas minerals is taken from the monograph, "Useful Minerals of the U. S., Albert Williams, Jr., U. S. Geol. Surv., Rept. 1887, Mineral Resources of the U. S."

Prof. Williams, in his monograph, states as follows:

"In addition to the State Geologist, mining engineers and others who contributed material to the list of mineral localities published in Mineral Resources, 1882, special thanks are due the following named gentlemen for new fnformation regarding the mineral occurrences of the respective States and Territories: Arkansas—J. C. Branner, F. W. Gibb, W. A. Chapman, F. B. Harvey."

(The * designates later additions, for which the author is alone responsible.)

ARKANSAS MINERALS MINED.

Mineralogical Name.	Common Name.	Remarks.
Anglesite*	Carbonate of lead	Near Dodd City, Marion Co.
Agate	Quartz.....	Finely variegated, Montgomery Co.
Alabaster*	Sulphate of lime.	Sebastian, Boone, Searcy and Marion Cos., in the latter, Durst's cave, with onyx.
.....	Brick clay.....	Several varieties.
Calamine	Silicate of zinc..	*In massive and mammillary forms, as incrustations, Boone, Marion, Searcy Cos.
Coal.....	Coal.....	Area about 7000 square miles; varieties, bituminous, semi-anthracite; localities, Washington, Franklin, Crawford, Sebastian, Yell and Pope Cos. *These coals are peculiarly adapted to metallurgical purposes.
Galena	Sulphide of lead.	Pulaski Co., (silver, lead and zinc), Carroll Lawrence Cos., Marion Co., (partly argentiferous). Newton and Searcy (argentiferous), Sevier Co., (with antimony ore and argentiferous), Garland, Howard, Scott, Polk, (partly argentiferous and associated chaleopyrite, sphalerite), Montgomery and Pike Cos., many new mines opened; more or less antimony in nearly all mines lately opened.
Graphite*	Black lead, plumbago	Extensive deposits in Hot Spring Co., lesser ones in Garland, Montgomery, Howard and Pike Cos.
Granite	.....	Near Little Rock, Pulaski Co., near Benton, Saline Co.
Hydrozincite ...	Marionite zinc, carbonate earthy calamine	Marion Co., *Boone and Searcy Cos.
Jamesonite	Lead and antimony sulphide...	Antimony City mines, Sevier Co., *rare species geocronite and zenkenite occur also.
Limestone.....	....	Black limestone for ornamental and inside work, oolite limestone, Independence Co., *the first also in Searcy Co.
Lithographic....	.....	Searcy, *Marion, Boone Cos.

ARKANSAS MINERALS MINED.—*Continued.*

Mineralogical Name.	Common Name.	Remarks.
....	Marble	Carroll, Newton Searcy, Madison Marion, Boone and Stone Cos., encrenital, red, pink and grey.
.....	Marl	Calcareous and shell marls in Green Co., Clark Hempstead, Pike, Jefferson, Lonoke, Madison, St Francis Cos., gypseous marls, Pike and Greene Cos.
Mexican onyx*..	Carbonate of lime	In caves as stalactites and stalignites, Marion Co., near Dodd's City, Boone, Stone and Searcy Cos.
Millerite	Nickel sulphide .	Rabbetfoot mine, near Benton, Saline Co.
.....	Mill and buhr stone	Independence, Searcy and Ixard Cos.
Novaculite	.....	Several localities in Hot Spring, Garland and Saline Cos., known as Ouachita oil stone, Arkansas stone; mined principally at Whetstone mountain.
.....	Potters' clay ...	Near Benton, Saline Co., Texarkana, Miller Co., Arkadelphia, Clark Co., *Pike Co.
Psilomelane	Manganese ore..	Near Batesville, Independence Co., and elsewhere.
Pyrolusite	Manganese dioxide	Near Little Rock, Pulaski Co., near Batesville and Cushman, Independence Co.
Quartz	Hot Springs diamond.....	Crystal mountains, Montgomery Co.
.....	Sandstone	Cabin Creek, Johnson Co., Dardanelle, Yell Co., Batesville, Independence Co.
Argantum	Silver blend. ...	In Galena, blend, chalco-pyrite and iron ores, Independence, Lawrence and Pulaski Cos.
Sphalerite	Sulphide of zinc.	*The most extensive deposits are those of Marion, Boone, Searcy and Newton Cos., crystals rare.
Syenite	.....	Cove Creek, Montgomery Co., Little Rock, Pulaski Co.
Tetrahedrite	Antimonial, copper, gray copper.....	Kellogg mine, 10 miles north of Little Rock, Pulaski Co., with argentiferous galena.
.....	Zinc ores.....	With many of the lead occurrences.

MINERALS NOT MINED.

Mineralogical Name.	Common Name.	Remarks.
Apatite	Phosphate of lime	Magnet Cove, Hot Spring Co.
Azurite	Carbonate of copper	As an incrustation, Sevier, Saline, and Montgomery Cos. *In nodules (sparingly), Searcy Co.
Aurichalcite* ...	Zinc and copper sulphide	In druse cavities in blend, Marion Co.
Brannerite*.....	Carbonate of zinc	Decomposition product (sparingly), in Boone, Marion and Searcy Cos.
Bitumen*	.....	Marion Co., in limestone.
Baryta	Heavy spar sulphide of baryta	Montgomery and Polk Cos.
Bauxite	.....	Heavy and extensive deposits near Little Rock, Pulaski Co., discovered by J. C. Branner.
Brookite	Titannic acid ...	Magnet Cove, Hot Spring Co.
Calamine.....	Zinc silicate.....	Sharp, Lawrence, Searcy, *Newton, Boone, and Marion Cos.
(Greenochite*) Cadmium, blend	Sulphide of cadmium	As as incrustation on zinc ores, Marion Co.
Celestite	Sulphide of strontia	White and Pike Cos.
Chalcopyrite	Sulphide of iron and copper ...	With galena, Pulaski, Sevier, Howard, Polk, Pike, Hot Spring, Montgomery, Saline Cos. *Also in Marion Co. In Searcy Co., associated with malachite and melaconite.
Coal—variety, lignite	Brown coal	Ashley, Bradley, Dallas, Green, Ouachita, Saline and Union Cos. *Also Pike Co.
Cuprite*	Red oxide of copper	Sevier Co. (sparingly); in some quantity, Searcy Co.
.....	Fire-clay	Sebastian, Pike and Crawford Cos.
Galena.....	See first part of list	*The heaviest deposits occur on Short Mountain, Marion Co.
Aurum.....	Gold	Said to occur at Silver City, in quartz; at the Bellah mine, Sevier Co.; also in pyrites of iron of doubtful importance. *The character of the region justifies the exploration for gold. Its occurrence in certain portions of Montgomery, Pike, Howard, Sevier and Polk Cos. is very probable.
Gypsum.....	Sulphide of lime.	Green Co. in clay on Little Missouri river; Pike Co., extensive deposits; Plaster Bluffs, and three miles east of Murfeesborough.
Halite	Rock salt.....	Dallas and Hot Spring Cos.
Hematite.....	Red iron ore....	Marion Co; *in Lafferty Creek, Independence Co.; latter County, sparingly.
.....	Hydraulic limestone	Saline, and many counties in the northern part of state.

MINERALS NOT MINED.—*Continued.*

Mineralogical Name.	Common Name.	Remarks.
Hydrozincite ...	.....	Lawrence, Searcy, Marion, Baxter and Polk Cos.
Jamesonite	.....	See first part of list.
Kaolin.....	.....	Pulaski and Saline Cos.; *also Pike and Boone Cos.
Limonite.....	Brown hemitite iron ore.....	Carroll, Fulton, Lawrence, Ouachita. Pulaski, Randolph, Saline, Montgomery, Polk, Washington, White, Sebastian, Howard and Sevier Cos.
.....	Ochre	Yellow, Greene Co.; *red, yellow, Marion Co.
Magnetite	Magnetic iron ore	Magnet Cove, Hot Spring Co., abundant on surface as lodestone of fine quality; *in Columbia Co., as a fine black sand; very pure ore.
Malachite	Green carbonate of copper.....	Sevier, Montgomery and Pulaski Cos., as an incrustation only. *In quantity in nodules and radiating crystalline form, massive, Searcy Co.
Marcassite	Iron pyrites.....	In thick sheets and pseudomorphs in lignite beads, Wolf Creek, Pike Co.; massive in Marion and Searcy Cos.
Melaconite	Black oxide of copper	Tomahawk mines, Searcy Co., in large quantity, *associated with chalcopyrite, malachite and cuprite.
Muscovite	Mica	Magnet Cove, Hot Spring Co.
Nitre	Saltpeter	Marion and Newton Cos., in caves.
Perofskite	Titanite of lime..	Magnet Cove, Hot Spring Co.
Petroleum	.....	Scott Co.
.....	Potters clay.....	Green, Pulaski, Saline, Clark and Miller Cos.
Psilomelane.....	Manganese ore..	See first part of list.
Pyrites.....	Sulphide of iron.	Hot Spring Co., vein reported four yards wide; Pulaski, Montgomery, *Polk, Pike, Marion, Searcy and Boone Cos.
Pyrolusite	Manganese dioxide	Polk, Pulaski, Howard and Montgomery Cos.
Quartz.....	Rock crystal....	Montgomery Co., sparingly in Howard and Severe Cos.
Rutile	Tetanic acid....	Magnet Cove, Hot Spring Co., *massive and in trimmed crystals.
.....	Sandstone	Franklin, Searcy, Johnson, Van Buren, Yell and Independence Cos.
.....	Sand	For glass making; Marion, Boone and Searcy Cos.
Saline waters* ..	.....	Sevier and Franklin Cos.
Serpentine.....	.....	Magnet Cove, Hot Spring Co.; Polk Co.
Siderite	Spaltuc iron	Franklin Co., thin beds, in sheets; Madison Pope, White, Johnson, Van Buren, Washington and Saline Cos., in shales.
Silica	Amorphous.....	Eight miles north of Batesville, Independence Co., formerly utilized as a polish and sold in St. Louis. *Occurs also in several localities in Boone and Marion Cos., of good grade.
.....	Slate and flagstone	Pulaski, Saline and Polk Cos.

MINERALS NOT MINED.—*Concluded.*

Mineralogical Name.	Common Name.	Remarks.
Smithsonite.....	Carbonate of zinc	In incrustations in limestone, Lawrence Co.; *Marion, Boone, Searcy and Newton Cos.
Strontianite*....	Carbonate of strontium	Near the Morning Star mine, Marion Co.; as an interstratification of the limestones.
Sphalerite	.....	See first list.
Steatite	Talc, soapstone .	Large deposits in Saline and Pulaski Cos.
Stibnite	Antimony sulphide	Several localities in Sevier Co., with ochre. *Jamesonite, Geoermite. Jinkenite, and other rare species of arsenica minerals.
Wad	Bog manganese .	North fork of White River, Izard Co.
Zincite.....	Zinc oxide.....	Lawrence Co.

ARKANSAS GEMSTONES.

Mineralogical Name.	Common Name.	Remarks.
Agate	Quartz	Occurs finely variegated, Montgomery Co.
Amethyst	.....	Perfect crystals, small and rare, Montgomery and Yell Cos.
Alamandine	Manganese, garnet	Some crystals, large, fine, ruby red, Magnet Cove, Hot Spring Co.
Agerite	.....	Jet black, lustrous prisms, Saline Co., as above.
Crysolite	Olivine	Blue and green crystals, small, Magnet Cove, Hot Spring, Montgomery, Saline and Pulaski Cos.
Cocolile	.....	Green, Magnet Cove, Hot Spring Co.
Ealolite.....	Sunstone garnet.	In nodular masses, massive, also inclosing pyrites, subordinate, Magnet Cave, Hot Spring Co.
Gossularite.....	Cinnamon stone	Magnet Cove. Hot Spring Co.
Jasper	Quartz	Hot Spring, Garland, Montgomery and Polk Cos.
Melanite	Black garnet....	Very large crystals, as schorlamite, black lustres, seldom perfect of same composition, Magnet Cove, Hot Spirng Co.
Microline	Amazon stone...	Samples found, of little value, Magnet Cove, Hot Spring Co.
Pearls	.....	Occur of large size in common mussels in White river, Buffalo river, Marion Co.
Perofskite	.....	Occur in cubes, quite perfect, very lustrous, black, Magnet Cove, Hot Spring Co.
Prase.....	.....	Green, Saline and Montgomery Cos.
Rutile	Titanic acid.....	Rosettes, formed by trimming, perfect, unique, Magnet Cove, Hot Spring Co.
Rock Crystal ...	Quartz	Clear, pink, green, doubly terminated crystals, crystal nuts, much used for jewelry, Montgomery Co.
Schorlamite	.....	See melanite.
Topaz	Quartz	Magnet Cove, Hot Spring Co.
Smithsonite	Carbonate of zinc	Pearly lustre, rich, deep yellow and creamy white colors; perfectly adapted to use as a gem, Marion county.*

In the preparation of this list much assistance has been derived from the reports of the State Geological Survey under Dr. J. C. Branner. For list of reports, see below.

Collections of Arkansas minerals, named and labeled in accordance with Dana's system of mineralogy, for sale or exchange for minerals, works treating on chemistry, assaying, metallurgy, technology, mineralogy and geology, address the author.

THE REPORTS OF THE GEOLOGICAL SURVEY OF ARKANSAS.

Persons seeking information, regarding the mineral resources of Arkansas, will find official reports upon its geology in the volumes published by the State Geologist, Dr. John C. Branner. The law provides that a certain number of these reports shall be distributed to scientists and capitalists by the Secretary of State, who, however, "shall request the applicant to state in writing that he is a scientist or capitalist, and that he wishes the reports to aid him in investigating the mineral resources of the State." Applicants are required to pay postage or express charges on the reports.

The subjects of the separate volumes, and the prices at which they are sold, are as follows:

	SUBJECT OF THE REPORT.	Price.
1888, Vol. I.	Gold and Silver, (Western-Central Ark.)	$1 00
1888, Vol. II.	Mesozoic (Chalk, Southwest Ark.)	1 00
1888, Vol. III.	Coal (Preliminary Report)	75
1888, Vol. IV.	Washington county (Plant List)	1 00
1889, Vol. II.	Crowley's Ridge (Northeast Ark.)	1 00
1890, Vol. I.	Manganese	1 35
1890, Vol. II.	Igneous Rocks ("Granites")	1 35
1890, Vol. III.	Novaculites (Whetstones)	1 35
1890, Vol. IV.	Marble and Limestone (North Ark.)	1 50
1891, Vol. I.	Mineral Waters	1 00
1892, Vol. I.	Iron Deposits	1 00

The following volumes are in various stages of preparation:

1. Clays, Kaolins and Bauxites.
2. Coal (Complete Final Report).
3. Zinc and Lead.
4. Tertiary Geology (South Arkansas).
5. Lower Coal Measures.
6. Miscellaneous Reports (containing Benton county, Dallas county, Elevations, Bibliography of the Geology of Arkansas, Magnetic Observations, etc.)

OUTLINE.

The zinc and lead region embraces the northeastern portion of Boone, the greater part of Marion, the northern portion of Searcy, and the northwestern part of Newton Counties. The boundaries of this region, "as determined by the occurrence of ores," is very irregular in outline, and, as yet, only approximately known. It ranges in width from six to twenty miles, and approaches forty in length. In various localities throughout the region occurs some of the most remarkable zinc ore deposits yet discovered. These deposits, together with other occurring ores "of commercial importance," are those which form the subject herein treated of. The trend of the ore-bearing lands, "as determined by the relation of ore deposits," is nearly northwest southeast—a line passing through Yellville and Dodd City effects, "as near as may be," the separation of the region into two (approximately) equal parts.

PANTOGRAPHY.

Like sentinels, towering mountains encircle the border of this wonderland, and hold within their wild and rugged fastnesses, vast and inexhaustible stores of wealth, unrivaled even by those of India's far-famed mines, or the possibilities of Aladdin's lamp. Entering near the northwest corner, the broad waters of the picturesque White River sweeps in majestic beauty, graceful curves and narrow bendings, doubling and turning upon its course in its southeastward journey through this treasure house of the southwest, past fertile fields and cozy homes, nestling about the foot of mountains that spring from the limpid water's

side, leaving mirrored there the ever-changing beauties of their forest-clad slopes; past overhanging cliffs, where carved in rude and fantastic form, gigantic stairways lead upward to seeming castles, cities and ruins, guarded by grotesque forms in stone, of birds and beasts. Wide-reaching arches span the entrance of caverns, in the obscure depths of which are untold and unknown possibilities. Shadowy forms, snowy in their whiteness and quaintly draped, stand or recline on alabaster couches, and in the flickering of the torchlight, seem endowed with life, and the embodiment of an Arabian tale of enchantment.

Marble palaces, rivaling those of kings, may here be built, the cost of which, is only, that of labor of erection. Red, pink, blue, gray, variegated, encrinital and ruin marble are known so abundant and so little valued, that log cabins rest on marble walls, and the curling smoke ascends through marble chimneys. Of such quality, is it, that inferior stone has been used to record the deeds of heroes and perpetuate the fame of a nation's dead. Nor are sites of palaces wanting in this Switzerland of the South. Cutting deep into the rugged mountain sides, valleys wind in and out, broadening into parks or narrowing into walled canons, whose overhanging cliffs quaintly fashioned into curious forms by the storms of ages, embrace within their fastnesses romantic glens and weird nooks. Terraced slopes recede upward to dome-shaped summits from whose heights a panorama of indescribable beauty and grandeur opens up to view. Enormous blocks of stone are strewn and piled about the mountain sides as if by Titans in their play. Flowers, ferns, creeping vines and mosses tone down their ruggedness and clothe in beauty their time-worn sides.

The pine forests lend to the passing breeze balmy odors, health-giving in their power, and in the murmuring of their leaves is found a melody that soothes and quiets the weary mind. Waters pure and cold, sweet as the nectar of the gods, spring from a soil rich in productiveness. Here health and wealth, twin sisters of happiness, may be found, and peace and quietness had for the seeking.

WHITE RIVER.

*"Any one taking the trouble to read the Annual Reports of the Chief of Engineers for the past twelve years will be struck with the uniform testimony of engineers in regard to the future great commerce of this river, a significant fact in itself."

*From Report of Chief of United States Engineers, of 1888, page 1405, report of Captain Taber, engineer in charge of White River improvements:

This river has, "since the early settlement of the country," been the commercial highway of the region traversed by it. In the years preceding and immediately following the civil war all were awake to the importance of this noble river, which then was the only means of transportation available to the commerce of a vast territory. From Forsythe, in Missouri, "then the head of navigation," downward, enormous crops of cotton floated to eastern markets, and imports of like magnitude found their way inland on the broad bosom of this river. The Federal and Confederate Governments availed themselves (see official reports of the civil war) of the facilities offered, in the transportation of men and material. Then recognized as a stream adapted to the purposes of commerce, it has since been improved, by the deepening of the channel, through the removal of shoals and rocks, which "in time of low water" obstructed the passage of steamers. This improvement extended from Batesville, "the railroad terminus," to Buffalo City, "in Marion county," between which points no impediment now exists to the passage of ore-laden boats during ordinary years. From Buffalo City to the northern limit of the region outlined, "a distance of sixty miles by water," to steamers and ore barges, this portion of the river is navigable for three-fourths or more of the year. An appropriation of $8000, "deemed ample by the engineer in charge," was made for the removal of the obstructions in this portion of the river. The work has been begun and completed within the year, thereby affording miners access to market at all times. The river ranges in width from 75 to 150 yards. Boat-landings are

common, and easily accessible. The valleys of the tributary streams, "quite numerous throughout the region," afford every facility requisite to the construction of good wagon-roads or tramways.

The importance of White River as a factor in the development of the natural resources of the region traversed by it can hardly be over-estimated. Its presence gives assurance of cheap and easily available transportation, to the miner for his ores and to the manufacturer for his wares. Even by the stoppage of navigation for a period of four months by low water, "an exceedingly rare occurrence," the commercial utility of the river, "as compared with northern and eastern waterways," is in no degree lessened, as while the waterways of those regions are bound in fetters of ice this river is open to traffic.

BUFFALO RIVER.

This river is 50 to 75 yards in width, and flows in a northeasterly course through the southeastern part of the outlined territory, and empties into White River near Buffalo City.

It is available for the transportation of ores for seven to eight months of the year.

ORE BARGES.

A barge of fifty tons capacity measures 50×12 feet; can be built at a cost of $50; further carrying capacity can be had at an average cost of $1 per ton. On delivery of the ore at railroad terminus, the barge can be disposed of as second-class lumber, thereby effecting a further reduction of cost of delivery. Three men, at $2 per day, can run a barge down in three days.

ORE SACKS.

Sacks should be made about 12×14 inches, of very heavy canvas; ¼-inch sea-grass rope should be sewn around three sides, leaving four inches unsewn on two sides to form hand grasps, by which means handling is facilitated, and greatly reduced in cost. Seams should be strongly sewn. Such sacks last many months, and soon in the saving of ore, repay first

cost. Made of the size stated, the sacks will hold about 100 pounds of ore each. After shipment they are of course returned.

COST OF TRANSPORTATION BY BARGE.

Buffalo City to Batesville, $1.50 per ton of 2000 pounds; Batesville to St. Louis, $2.75 per ton of 2000 pounds. Total, $4.25 per ton.

TRANSPORTATION BY STEAMER.

Buffalo City to Batesville, $1.75 to $3.00 per ton.

COSMOGONY AND CHEMISTRY OF THE CREATIVE PERIOD.

Look which way we may for that period in which time began, or matter had its origin, we nowhere find anything so full, complete, and in such harmonious accord with the revelations of nature, as in the opening page of the first chapter of Genesis.

The creative acts as there depicted, are such as no mortal eye had seen, nor could the mind of man have formulated a scheme of such broad and profound philosophy, having a sequented series of acts arranged in an order not consistent with the faulty conceptions of the mortal. The prophetic character of the narration of the events of the creation becomes more apparent with the lapse of time, and the acquisition of knowledge, and acquires a broader, deeper meaning from the directive force which had origin in the progressive character of the manner of creation. This feature becomes more evident as we become conversant with the incompleteness of the present, and its relation to future time, when time shall cease, and all things be in a state of rest. That the writer was inspired, is evident; that the creation was the act of an omnipotent being is demonstrated by the infinite wisdom everywhere displayed in nature; each stone, leaf or flower is a design, and implies the existence of a designer; all are whisperings of an Almighty God and his wondrous power.

"In the beginning God created the heaven and the earth."

Here we have the first act of the creation, and the time of such act is quite as definitely fixed as if a day and a year had been expressed; and whether this "begining" was 6000, 60,000 or 60,000,000 of years from a place in time we assume to know, is quite immaterial to the fact of that beginning, or the mode of its occurrence. The following passage is explanatory of the stage of advancement of the first act. "And the earth was without form and void, and darkness was upon the face of the deep." In the beginning the elements of which the earth and all upon it, is composed, was brought together by divine mandate; their assemblage and grouping into such forms, as we know as solids, was an after event, as "the earth was without form and void." We cannot conceive of a mass of matter in nature fulfilling these conditions having other than a gaseous form.

That such conception, is true, is substantiated, first, by the sequence of events, as narrated by the inspired historians; second, that in our hands, all substances (with limited exceptions) can be vaporized; third, the form of the earth, an attribute it could not have possessed until it became individualized, nor could it have been without form had the constituent parts been in other than elementary form; fourth, such nebular or gaseous masses are known to have existence; fifth, the spectroscope reveals to us the presence of elementary forms of matter in the regions of space; sixth, the form of the earth, is only that which could have resulted from the crystalizing out, from a menstruum, which, in itself, formed the containing media of compounds of elementary forms generated by the laws of chemical affinity; seventh, the definite and characteristic accordance of such compounds and their universal distribution; eighth, stability of motion in fixed planes could only have been imparted to a body possessed of solidity and rigidity of form. From this we make the following deductions: That the earth was first a nebular mass, consisting of the elements in gaseous form, which now enters into its structure, and that during the creative period a gradual separation of the elements requisite to the formation of rocks

and ores, from those, which were essential to the formation of water and the atmosphere; the proportions of one or the other, being determined by the presence of those which could satisfy its affinity. And further, that if one or the other was in excess, then instability and change must ever form a characteristic of the matter entering into the earth's structure, and in consequence, the engendering of certain forces, co-associates of the act of creation, which, with resistless energy and ceaseless activity, in obedience to the will of God, strive to effect and maintain an equilibrium of forces and the preservation of matter as first formed. The action of these forces, among which electro and galvanic forces are manifest, and the power of gravitation declares itself, is progressive, cumulative and restorative, the effects of which they are the cause, form the laws of nature. They are the agents of God in the opening up to the use of man in each successive stage of life, the stores of sustenance of unlimited extent, limitless application and universal distribution, destined adequate to the needs of countless millions, so long as time shall last. All matter in, upon, or accessible from the earth, of whatsoever nature, kind or character, form or fashion, is of elementary form or a combination of two or more such forms. We recognize sixty-four elements, fifty of which are metals. Of the sixty-four there are some twenty-seven for which no practical use has as yet been found, and from their apparently limited occurrence in nature, we, in our present state of knowledge, regard them as of little importance in the economy of nature. Earth, air, fire and water were esteemed elementary forms of matter by the alchemists, and served as the basis of their operations in the attempted transmutation of metals. These supposed elementary forms of matter have, by us, been separated into simpler forms of matter. What has been, may be again. All ideas are the offspring of Nature's inspiration, and never die. In the distant future the forms of matter we now regard as elementary, "only because of our inability, through the absence of adequate means, or insufficiency of knowledge in the use of those we possess, to affect their separation or revolution

into simpler forms," may be demonstrated compound bodies ; if so, then in the backward swing of the pendulum of time, the dreams of the alchemist will have fruition, gold, and the sustenance of life be crystalized out from etherial depths.

The spectroscope reveals the presence of the same elementary forms of matter in space, as those of earth. Scientists generally regard the elements thus shown as being those entering into the structure of the planet examined. But the experiments of the author with this instrument has convinced him that such elements " supposedly present in a planet " are actually present within the outer limits of our atmosphere ; and that the apparent variation in number or kind, is simply due to the variation in quantity and intensity of light as transmitted by the various planets to the prisms of the instrument. This view, is supported by the fall from space of masses of an iron and nickel alloy, the formation of which, can reasonably be accounted for only on the supposition of their presence in space in gaseous form, and the subsequent action of electric forces. The position, that such meteoric masses had origin in the bursting asunder of a planet by the explosion of a force within itself, does too much violence to the understood laws of nature. The exertion of a projectile force requisite to project a 480-grain stone, or one of thirty tons, millions of miles, necessitates in view of the character of the opposing forces, a conception of mechanism rather too intricate for comprehension and wholly inadequate to such preservative action as is essential to the maintenance of its individuality until the attainment of the journey's end. Nature is progressive ; evolution is the method of that progression. The elimination of a planet, however small, from the realms of space, is retrogression and productive of a void. But to return from this digression. The character of the materials used in the construction of the earth, the method of the creation and the nature of the forces " originating in the creation," are such that there can be no destruction of matter, nor exhaustion of nature's resources. The agencies at work tearing down mountains, leveling plains, extending the coast lines or sinking land in the

sea, are also gathering together into receptacles prepared for them the materials requisite for use in future time, and rendering accessible to us those formed in past time. Such agencies are in part mechanical, in part chemical, and a union of the two. Of the second, is the formation of ore deposits. The forces effecting the decomposition, solution and subsequent precipitation of ores are purely chemical, galvanic and electrolytic action are the attendants of, or generated by, the action of such forces, and frequently demonstrate their presence through the occurrence in ore deposits of metallic elements of such nature that their affinity for non-metallic elements, would in a few days or weeks effect their transference into ores. Such influences are those which govern the action of those of nature's forces, which are now, and always have been actively engaged effecting alterations, and a consequent change of form in each and every substance in or upon the earth. To the continuous action of these forces, exerting themselves through long geological ages, are due the gathering together of widely separated atoms of ore, and the deposition of such atoms into deposits of workable extent. The primary condition of the individual ore atom may have been in the liquid, gaseous or solid form; its position as regards other forms of matter, may have been as the constituent part of an earth, a rock, a tree or a shrub. And its separation (from either the one or the other of these forms of matter) was affected through a partial or complete decomposition of the original containing substance; this separation may have been effected by mechanical or by chemical means, and it is with the latter that we, as prospectors, have to do. In all the various forms of seeming destruction every day seen there is no destruction of matter. Man can neither create or destroy a single atom of matter; the atoms have existed since the beginning, and to their existence there will be no end. Each and every substance, both organic and inorganic, upon the face of the earth, or within it, owes its existence to, if a compound body, the union in varying proportions of two or more elementary forms of matter whose selection and association was effected and governed by what

is termed chemical affinity. This affinity, however strong it may be, is much affected by various extraneous influences, as the approach "under certain circumstances" of other elements, or compounds of such, or the presentation to these compounds, of some liquid or gaseous menstruum, having an affinity for one or more elements, of one or both compoudd bodies, such, serves to destroy the stability of the compound bodies, through the unlocking or freeing of one or more elements, and the consequent dissolution of the original compounds; this dissolution is "usually" complete, and from it are determined a new series of simple or compound bodies, which, though differing in all respects from the first series, are composed of the elements (united in varying proportions and manner) which once formed the first. Such new compounds of the elementary atoms of matter or as stable and definite as the original; yet will, under like attending circumstances, suffer dissolution to give origin to other differing forms of matter. So it will be seen that in nature there is no rest, neither is there anything that was created in vain; each and every thing in nature has its use, and the existence of each and every other atom of matter is a potent factor in the existence in each and every other. It should not be supposed that the ceaseless changes and mutations which affect the earth and all upon it, take place promiscuously or by chance, for the laws governing these changes are as definite and immutably fixed as those which govern the motions of the planets through space. As the planets in their motions, so these changes in theirs. The ending of each is where the beginning was, as a circle—there is no end. Countless ages have elapsed since this ceaseless activity of nature's forces began in obedience to the Divine Maker's will. Ages must elapse ere His will has been fulfilled. Ages on ages have passed away since nature's forces began the gathering together of the various kinds of ores, and the placing of them, atom by atom, in the receptacles from which man now obtains the means, the possession of which enables him to advance toward a higher plane of life and intellectuality. Slowly but surely the obscurity which

shrouds nature's works is being dispelled. The students delving into the archives of nature's laboratory are acquiring one by one the secrets of her processes. This progress is daily being manifested in the wondrous achievements of inventive genius, whose seemingly most visionary dreamings are being embodied in tangible form. The forked fires which gleam and flash through the murkiness of an overcast sky, is the visible evidence of the existence of a key through the use of which there will be opened up to mankind untold wealth, and the means to utilize it.

The formation of deposits of ores or other substances, then has in each a direct reference to man, his needs and necessities. They are the product of long-continued action of various forces; the action of which is restricted to the attainment of a given end, in a given manner, for a purpose conceived before the world was. The directive agency of these forces is God. The object of their being is the continuance of man, to whom they give body, afford sustenance and the origin of his ideas. They being the media through which the creator imparts knowledge to man, directing him to each provision devised for the continuance of his existence, in such times, as each, becomes essential to the attainment of that end. In some future cycle of time, those things we, in our ignorance, cast aside, will be found essential factors in the existence of life. The time is now at hand when the exigencies of life in its present status demands heretofore unknown resources for its harmonious continuance. Such resources have been made known. Electric force, the key to them, is in our hands.

ORE DEPOSITS.

ZINC ORES.

Ore-Bearing Strata.—The great zinc ore-bearing strata of this region, and the source from which all other occurring deposits derived their containditure of zinc ores, is that numbered (5) of the stratigraphical chart. The geological horizon of the strata, is constant throughout the region; seeming variations of

level attend its course, but are in all instances such, only apparently, they being due to and originating in the presence or absence of associate overlying stratas, and the comparative rapidity of the ascent of the valley, as its head or upper terminal is approached.

This strata is easily recognized by the occurrence "on weathered surfaces" of small aggregations of tiny limpid quartz crystals, which more or less abundantly stud the rock, projecting a line or two above its surface. In color, the rock is, on exposed surfaces, dull bluish-gray; on freshly-broken surfaces, is dark gray to yellowish gray. The presence of minute quartz crystals gives a glistening-like look to the rock. It is very hard, brittle, compact and close-grained in texture, and of subconchoidal fracture. A peculiar and unpleasant odor is evolved by the rock when rapidly struck with a hammer.

Chemical Composition.—The chemical composition of this rock, in so far as relates to its component parts, is constant, but variations of greater or lesser degree are manifested in the quantity of each constituent part present, and the proportion such quantity bears to that of the combined mass of the others. This variation is evinced in a characteristic manner in the clay beds, which result from the decomposition of the strata; and the degree of resistance offered to the destructive action of atmospheric agencies by top and bottom of the same exposure, or adjoining portions of the same strata. The following

Analyses of Dolomite (so-called).

(No. 34.)	(32.)	(1.)	(2.)
State Geol. Rep., D. D. Owen.	Elderhorst Chemist.,	W. Albert Chapman.	
Silica with trace of clay...	3.191	insoluble	6.707
Alumina with trace of iron,	3.023		
Carbonate of lime	50.041		53.998
Carbonate of magnesia	42.317		35.059
Carbonate of zinc	1.950		1.978
Potash with trace of soda.	0.435	carb. iron.	2.253
Moisture	0.128	potash	0.106
silica	10.00		10.25
alumina	11.25		9.20
	45.50		45.00
	34.25		36.00
oxide zinc.	1.00		
			0.55
	0.25	sulphur...	0.33

Partially Illustrate Variance of Composition.—The samples Nos. 34 and 32 were selected by Prof. Elderhorst, the one from

a Marion County zinc mine, the other, from a Lawrence County mine. No. 1, a yellowish colored sample, from upper side of strata, and No. 2, a hydrated sample, from the lower part of same strata. The greater part of the stratas of this system contain in varying proportions certain constituents, more or less perfectly soluble in carbonated waters, the action of which, opens the way to the mechanical forms of energy "in rock disintegration" as existent in heat, cold and moisture. In no member of the strata, is this disintegration or breaking down of the rock more rapid, radical or completely effected than in this ore-bearing strata. The manner of the destruction and the character of the products of such destruction, are determined by the materials entering into its structure, the manner of association, position and situation. Where the rock is barren, the dissolution of the rock is comparatively slow and irregular, an is manifested in the formation of fissures, filled in with sand and clay, and the separation of large massive boulders from the parent strata. The clays originating from this source contain such quantity of quartz crystals that in the sunlight the eye is attracted by their sparkle. This soil, is not productive, and yields support to but few forms of vegetation. In immediate contact with sulphide of zinc, the action of dissolution is energetic and reciprocal, the rock being transformed into red clay and the ore bodies become deeply and more or less completely eroded. Often where such body was silicious a skeleton of silica only remains. Where this process begins and is confined to a small cavity, carbonate of zinc forms, zinc and iron sulphates saturate the clay and penetrate the rock to greater depth. Should the body of ore have been extensive, the ruin and wreckage of the veinstone or strata is widespread. The limits are in general well defined by the protrusion from the clay bed of irregular boulders and masses of rock, which unmistakably show evidence of the action of corrosive matter. Frequently quantities of the ore have escaped complete solution and remain *in situ*, giving origin to ore deposits inclosed in a matrix of clay. The changes begun in the dissolution of the rock do not culminate in the actual de-

struction of the rock, but find further expression in a more or less perfect transposition of the silicious matter to the lower part of the bed, the ores and clays forming the upper portion. It is difficult to understand by what means and in what manner this result is attained, unless it be effected by rains and melting snow. The oxide of iron, once a constituent of the rock, unites, forming deposits of hematite. These are sometimes of such apparent extent as to lead to the assumption of this being adequate to the demands of a furnace. Those portions of the rock which embraced quartz in massive, divergent or other forms, have on their removal left intact silicious skeletons of peculiar shape and of the most exquisite fashioning. These and the iron ores invariably mark the soil in which zinc ores are or were present, and as surface indications are hardly inferior to the surface presence of the ore itself. Deposits so occurring are easily and cheaply explored. The ores are marketable in the forms removed.

GEOLOGY.

For long geological ages after the earth had acquired form, nature's forces were in active operation, then, as now, in remodeling the earth and preparing it for the advent of man. Each progressive stage had origin in periods of sudden and violent acts, succeeded by periods of comparative quiet, extended over regions of greater or lesser extent, and through varying durations of time. Such periods were of alternate occurrence as regards place, but never, at any time, universal in act. The forces which affected alterations in the character of the first epoch, also modified the results and evidences of those of the geological disturbances due to the succeeding epoch. The frequent repetition of such periods, each being in a marked manner radically changed by that succeeding, thereby characterizing each period of geological disturbance in such way that each in some respect differs from any and all others. It is upon the observation of the results of such occurrences, the world over, that the science of geology rests. The science, is but the result of observations of thousands of

men delving in mines, on the mountain tops, the basins of valleys and the bottoms of the sea. Each of the thousands contributed his mite of experience and the whole elucidated by laws deduced from long continous observations of the manifestations of nature's forces, harmoniously interwoven from the science of geology.

GEOLOGY OF THE REGION.

The geological formation of this region had its origin in a quiescent period, and was formed upon the bottom of an ocean, from the water of which, subsided the material entering into the structure of the rocks. Each strata, forms a record of the continuance of certain acts governing its formation for a certain period of time, each variation in strata, being due to some disturbance of the order of things, as existent in the formation of the preceding strata. The rock forming period of each system of rocks of sedimentary origin, was brought to a close on the subsidence of the overlaying sea, or the elevation of the land by subterranean forces, and is outlined in the thickness of the mass. The variation in kind, in strata is resultant from the character of rock, the disintegration of which afforded the material of the structure of the second, and the manner of introduction and mode of subsidence.

The geological formation of this region is, so far as examined by the writer, that of the lower silurian period, overlaid in certain localities by members of the subcarboniferous period. No evidences of the action of volcanic agencies are anywhere observable throughout the region, "other than an almost imperceptible inclination of the stratas to the southeastward, where they pass under rocks of the devonian period." The exposures of the silurian rocks are, in major part, magnesian limestones, varying quite materially in structure and composition, and arranged in horizontal beds or layers, which vary in thickness from that of a few inches to that of fifty feet or more. In texture the strata are porous to compact, and subcrystalline. In hardness the variation is no less great, some varieties being soft and chalky-like, others like indurated

quartzite, while others resemble flint, and locally are so called. Members are not wanting in which cleavage lines are present. The fracture, is in general, however, irregular to sub-conchoidal. While the stratas are essentially magnesian limestone, the character of each strata is modified by the presence of varying proportions of silica and alumina, and the preponderance of either lime or magnesia, in each. In a sequential series of stratas, in an exposure of 250 to 300 feet, the following rocks may be observed: A silicious argillacious limestone, a silicious magnesian limestone, an argillacious magnesian limestone, a silicious argillacious magnesian limestone, (dolomite) limestone, magnesium limestone, sandstone and buhrstone. The overlaying members of the subcarboniferous formation, "where present," consist of compact subcrystalline limestone, both sparry and crinoidal, with inter-stratifications of calcarious sandstones. The series approximates seventy feet in thickness, and is overlaid in some localities by chert, which is probably resultant from the decomposition of the buhrstone strata, remaining masses of which are here and there seen. The aggregate thickness of the exposures is that of the elevation of the hills composed of them, and ranges from an altitude of 75 feet to that of 500 feet. The height of the hills is dependent upon the number of the uppermost strata removed by erosion. Within the mass, which is referable to the Canadian period, and the equivalent of the calciferous sand rock of the New York system, sandstone strata of varying thicknesses occur as interstratifications, at various elevations in the mountain mass, of which the following list shows the order of sequence from the base upward:

First, base of most exposures, a thin bedded-magnesian limestone; 2d, compact grey magnesian limestone; 3d, thin-bedded shaly magnesian limestone; 4th, compact, grey magnesian limestone; 5th, six to eight inch beds of light grey limestone; 6th, bluish, compact limestone; 7th, silicious argillcious, magnesian limestone (dolomite); 8th, variegated, yellowish grey magnesian limestone; 9th, cotton rock (limestone); 10th, variegated, bluish grey magnesian limestone;

11th, calcarious sandstone ; 12th, salicious compact limestone; 13th, magnesian limestone ; 14th, bird's-eye limestone ; 15th, compact sparry limestone ; 16th, thin-bedded, decomposable magnesian limestone ; 17th, soft, friable coarse-grained sandstone ; 18th, salicious limestone ; 19th, white saccharoidal sandstone ; 20th, shaly thin-bedded encrinital marble ; 21st, calciferous sandstone ; 22d, compact sparry marble ; 23d, grey encrinital marble ; 24th, red, pink and variegated marbles ; 25th, thin bedded limestone ; 26th, chert. The primitive horizontal position of the stratas is constant. Such alterations as has been effected in the formations are due to causes the action of which, began in the emergence of the formation from the waters of the sea. The character of each strata of the formation, is dependent upon that of the more ancient rock, the decomposition of which afforded the material entering into its structure and the manner in which such matter was deposited.

TOPOGRAPHICAL FEATURES.

Deep, narrow, tortuous valleys wind between long oval ridges and dome-shaped hills, the trend of which is northeasterly. Bluffs and precipices form the terminus of many of the outlying ridges; others recede from the mountain ridge to the valleys by gradual and easy descent. The summits of the ridges are often contracted and narrow and again widen out into parks of many thousand acres in extent; in general, rolling, sometimes level. Here is seen basin-like depressions, often many feet in extent, into which the surface waters gather to find entrance into subterranean passages below. Now and then irregular pits with precipitious sides, occur, where the surface strata has sunk into an underlying cavern. Bordering on each stream and valley strata are seen in tilted position, effected by the subsidence of the superincumbent mass of undermined strata, the line of fracture and separation being outlined by a slight depression and the presence of rock tilted at various angles. These effects, and others, at times observable, are alike, the result of the erosive action of water.

Caverns and crevices are quite common throughout the region. From the easily decomposable strata, various other rocks are formed and occur, filling in caves, crevices, sinks and faults. Among these secondary products resulting from the disintegration of the primitive strata, there are seen soft pulverent sandstones, quartz, quartzite, calcite, satin spar, onyx, alabaster, clays, ochers, iron, lead and zinc ores, sometimes occurring massive, at others crystallized. That the alterations everywhere observable in the exposed stratas are due to aqueous and atmospheric agencies, will readily be conceded after an examination; the more so as the process continues, and is in places, open to inspection. Water, be it remembered, comes nearer being the universal solvent (sought for by the alchemists) than any other known substance, and when an agent having such solvent powers acquires an additional increment by filtering through soft easily decomposable carbonacious substances, its erosive powers, as regards rocks, becomes almost irresistible as the more soluble constituent parts of the rock is dissolved and leached out, and under atmospheric action, the remainder is speedily disintegrated and passes into soil. Various, if not all ores, are affected by this in the same manner.

CHEMICAL ACTION.

An intricate and exceedingly complex series of chemical actions are engendered in the changes which intervene between the dissolution of the ore-yielding strata and the final completion of the secondary products resulting therefrom. In one direction such action has culmination in the disintegration of the ore-yielding strata, and the production of surface deposits of ores, but in the other no culmination of force is manifested, the line of direction of energy, is fairly well defined by the occurrence on the way, of crystallized calcite, quartz, carbonates of zinc, of copper, sulphides of iron and copper, formed and forming, dropped as burdens by the wayside from surcharged or saturated solutions, which are eventually discharged of their mineral contents, to the building up of a deposit of some one

or other of the above named minerals. Chemical affinity, a potent factor in such processes, while always existent, remains dormant until a means offers whereby a certain latitude of movement is permitted atoms or molecules of matter. Such means is had in the solvent powers of carbonated waters, which through chemical change when in contact with sulphide of zinc or iron, parts with the carbonic acid and becomes impregnated with sulphuric acid. Solutions of potash also have being and action in these changes, and effect the solution of silicates. Some few organic acids have part in some one or other of the many actions, such being perhaps restricted to a limitation of the action of others. Electro-galvanic forces are the directive agencies of each successive act. Exceptions to this may be taken by some, but the author, by means of several pairs of simple elements, variously arranged and buried in moist situations in ore deposits, had ample and satisfactory evidence of the generation of such force. The results of such experiments are likewise demonstrated in nature, by the occurrence of small pieces of metallic lead, zinc, antimony, copper and iron, in surface ore deposits, sometimes in ore bins and dumps. The occurrence of such metals, prone as they are to rapid oxidation, in association with corrosive matters, admits of no explanation on other basis.

RECEPTACLES OF ORES.

That one ore deposit might be formed from the destruction of another presupposes the entrance of solutions of metals into a receptacle capable of retaining such solutions until the mineral matter crystallizes out; or, possessed of active associate agencies, which on the incoming of the solution speedily effect such separation through a precipitation of the mineral matters. Receptacles of such nature are common throughout the magnesian limestone formation, and occur at all elevations, of all sizes, and of all forms. They are the caverns, crevices and fissures, which penetrate and ramify in all directions the rocks of this system. They are resultant from chemical and mechanical action of aqueous agencies. Necessarily it follows

that from the character of the source of supply of material, the nature of the subsequent changes, the irregularity in form of the final receptacle, origin must needs be given to deposits of equal irregularity of form and position, in which the introduced minerals can be no less variously associated, nor accordant in kind. The contents of some of these openings are onyx and alabaster, the receptacles being situated above the ore-bearing strata, or in localities from which such strata are absent. Others again are filled in with clays, sandstone, brecciated rock, tufacious limestone, quartz, calcite, calcarious spar. Of such materials one or the other may preponderate; all may occur, bedded, stalactitic, cemented, or loose and massive. Such may be barren of ores; or may form the matrix of ores of zinc, copper and iron, which may exist as carbonates, silicates, sulphides or oxides. Ore alone may fill the cavity, one variety of ore being the matrix of another. The mass may be crystalline or semi-crystalline in texture. Whatever its characteristics, it will materially differ from those of any stratified rock. The deposits may be small, or may extend for miles, in any direction, with numerous ramifications along its course, and to unknown depths. The process of formation of these deposits is in some localities open to inspection. The surface waters, percolating through soft calcarious strata, become saturated with carbonic acid and of lime. These, when sulphide of zinc is encountered, are in part deposited, and the solution becomes that of sulphuric acid, to which the ores and rocks speedily yield. Stalactites, beds and crevices are formed, and filled with the ores or material held in solution. Alkaline solutions effect the solution of the silica. Whether the solution be alkaline or acid the final process is the same. The mineral matters either crystallize out from the solution, or are precipitated in massive form by other agencies of stronger affinity. The various forms of deposits resulting from these causes are readily grouped.

First, as well-defined stratas, or blanket-form veins.

Second, as secondary irregular forms, of unknown extent.

Third, as inclined beds or strata.

There are no defined "true fissure veins," and so far as relates to the successful mining of zinc ores it is well there are not, for in no part of the world are such vein systems profitably worked if mined only for the zinc ores. The form of deposits as here seen are the only kind from which zinc ore can be profitably extracted, unless that of other forms of deposits contain certain quantities of gold or silver.

The deposits of the first class are found varying in thickness from a few inches to ten feet or more. The gangue, is usually limestone, and is easily crushed. Much of the ore "ready for shipment, in the form extracted," can usually be worked as a quarry, or by drifts. The deposits of the second class occur filling caves, crevices, and chimneys, and are often of great extent, two or more chambers filled with ores being contiguous and connected by lines of calc spar or ore, which may serve as a guide from chamber to chamber. The ores, of this class of deposits, may be found disseminated in a gangue of calc spar, dolomite, a silacious limestone, or free of such, mixed mechanically with clay. No regular method of mining can be pursued in working, as the tunnels and drifts must follow the pointers.

The deposits of the third class are those which occur in the fissures opened through the rupturing of the strata in a merely local faulting caused by the breaking off or subsidence of an undermined portion of the mountain. The greater part of the ores found in deposits of this form are free from gangue stone, being inclosed in clay. Sometime the ore is found in matrix of silica or limestone. This form of deposit is often of great richness in ore, as the ore has penetrated to the extreme end of the inclined stratum, even, sometimes replacing missing strata. These ores can be cheaply extracted through shaft and inclines. These classes are distinct in themselves, and occur on some properties in the region in such intimate association as to appear as one. Although the surface ores from many of the different zinc deposits in the region, have been found that were contaminated with lead, arsenic, iron, and

copper, they are not common; and as depth has been attained in working these deposits the increment of such in the ores has been found to rapidly decrease. The blends from a few of the deposits are cupriferous, carrying from 0.25 to 0.4 per cent. of copper. Others cadmiferous, yielding one to three per cent. of cadmium. Others, ferriferous, containing one to eight per cent. of iron. The purity and consequent superiority of Arkansas zinc ores as "compared with those of other regions of the United States, and of foreign countries" is demonstrated by even a casual comparison of the results of various analyses of samples of ores common to each.

An example of the class, where occurring upon the surface, is seen in the Full Moon mine. Here the vein-stone has been entirely broken up and given place to a strata of clay from which masses, often of tons in weight, put out of the ground over an area of some four acres on the summit of the hill. Fifty or more tons of choice ore has been removed, making but little impression on the quantity exposed. In the lower workings, ore also occurs in a vein-stone of limestone.

The Big Buffalo mine is a fine example of the first class of deposits. Openings have been made at numerous points, which, together with the natural exposures, reveal the largest deposit of zinc ore in blanket form yet discovered. Both these mines, occur in the Jimmy Creek region.

The Morning Star mine on Rush Creek, is an example of the second class of deposits. Here exposed to view, in a face some forty feet by one hundred or more feet, are tons of crystallized and massive carbonate and silicates of zinc, veins of blend and associations of all. The Leader, of Clabber Creek, and the Crown Point mines also, are examples of this class.

The Grey Eagle mine of Rush Creek, is an example of the third class of deposits. Here a missing strata was replaced by one of blend. These are all mines, and have paid and will continue to pay to work.

The greater part of the ores from the first, third, fourth, fifth

and sixth named, was ready for market as removed, requiring neither crushing nor jigging, and in the second named much free ore exists. These properties are mentioned by name merely as being typical of kind. Numerous properties have ores of equal quality and give promise of equal extent.

SHIPMENTS.

Hundreds of tons of ore have been shipped from four or five mines in the region at various times, and was sold in market at $18 to $27 per ton of 2000 pounds.

The cost of mining as given by the managers of different mining properties is as follows:

The Markle mine.....	$3	50	per ton,	30	tons of ore sold at	$27	00	per ton.
The South Star.....	2	50	"	"	25	"	"	"	26	00	"
The Leader.....	6	00	"	"	150	"	"	"	24	00	"
The Morning Star mine....	3	00	"	"	500	"	"	"	23	00	"
The Grey Eagle.....	2	75	"	"	200	"	"	"	26	00	"
The Full Moon mine.....		75	"	"	60	"	"	"	.....	"

Such figures include dead and preliminary work of first development of property. The ores can now be removed from several of the properties named at a cost of .20 to 1.50 per ton.

COST OF TRANSPORTATION

as given by shippers of ores:

From Leader, Grey Eagle or Morning Star.....	$4 75 per ton
From Shoney mines, Markles, South Star and others.....	5 50 "

Since which shipment rates have been materially decreased, and it is now estimated that the cost of shipment will not exceed $4.25 per ton to St. Louis, from any point on river bank. For above figures my thanks are due Mr. E. V. M. Powell, former superintendent of Leader mine, Mr. Jos. Barnes, of Markle mine, and Mr. J. H. Blake, of Grey Eagle mine and others. The magnesian limestones of the lower silurian formation is *par excellence* that richest in zinc ores.

LEAD ORE DEPOSITS

Galenas occur in quantity, as large cubical crystals, loose in the surface clays, over extensive areas; also in crystalline form

in a white magnesian limestone strata above the zinc-bearing dolomite. The most productive region, is that traversed by Sugar Loaf, Sugar Orchards, Sisters, Music and Jimmy's Creeks, and their numerous tributary streams.

In the Short Mountain range, the galena occurs in members of the subcarboniferous formation. Clay openings abound in which the ore is found mechanically mixed. The ores are also found traversing seams, fissures, and other openings in the rock. It is found in sheets, layers, stringers, massive boulders and minute crystals. The workings in no case exceed 60 feet in depth. Hundreds of thousands of pounds of lead have been raised here, and no locality offers better assurance of profit to the lead miner than does this region. In smelting, the ore yields 68 to 75 per cent. metallic lead; no more needs being said of quality, and the amount in sight and manner of occurrence gives assurance of quantity. In the mining but little powder is used, the deposits being workable with pick and shovel. No jigging or crushing is required, and a local market offers.

ALUMINUM.

Genesis, Uses, Economic Importance.—It would seem as though each cycle of time is marked by the use of some one metal to such a predominating extent as to stamp its name upon the age in which its use reaches the greatest perfection.

The adaptability of a metal to the requirements of a people, depends upon its characteristics and the perfection with which it meets the efforts made to fashion it into such articles of utility as the progress in ideas of the people has been able to devise. This adaptability of a metal to the use of a people and the degree of perfection attained by them in its application to such articles as they deem essential to their well-being, is in keeping the one with the other, or are in fact synonymous with advancement. Each stage of progression attained in civilization by a people, has been followed by a corresponding advance in their demands upon nature for the material with which to satisfy their increased needs. So also,

as the limit in the adaptability of a metal to their uses is reached, its use is suppressed by some other having a wider range of possible utility and characteristics more in keeping with the then advanced state of ideas. This has been so marked in the history of the world that various periods are designated by the metal, or its substitute, in the manufacture of which they then excelled. Thus stone and bronze marked each a period of the past, and iron soon will, within the century, mark another, for we stand upon the threshold of another age, coming through the setting aside of iron by a metal that excels it in abundance, and in such qualities as has given value to it.

When we pause and consider the progress made by the human race in civilization through the degree of perfection attained by it in the use of iron, we can but wonder as to what is in the future (in the way of progress through the use of the wonderful metal, *aluminum*).

Excelling each and all metals in those features which cause them to be valued, and having the most desirable of these united within itself, its applicability to the arts of life becomes evident, through the limitless range of its possible use, due to the peculiarities of the nature of the metal, the inventor will be enabled to embody many of his now seemingly visionary ideas into tangible forms.

This wonderful metal was first obtained by Wohler, "a celebrated German chemist," about seventy years ago, in minute globules, at a fabulous cost. For many years the metal was seen only in the laboratory of the chemist, and was regarded merely as a curiosity. In 1855, DeVille, a French chemist, succeeded in obtaining it in such quantity as permitted the determination of its characteristics, which, when known, crowned it the king of metals. These characteristics are so numerous, so wondrous and so peculiar, that none can foretell the progress of the arts, or the startling innovations which will mark its use in the mechanical industries.

Characteristics.—Bulk for bulk, it exceeds the weight of water but two and a half times. As white as silver, it is as

lustrous, and is susceptible to as fine a polish. Neither air nor moisture rusts or corrodes it. It is as untarnishable as gold, and more malleable than gold, silver, copper or lead. It may be hammered into leaves thiner than gold leaf, and drawn into wire so fine as to be almost invisible to the eye. It is softer than lead, and may be tempered to the hardness of steel. It is a better conductor of electricity than copper, and more sonorous than any other metal. It does not crystalize under blows nor through vibration. Its tensile strength is greater than that of iron or steel. It seemingly has the power of forming alloys with all other metals. Its melting point is intermediate between that of zinc and lead, but nearer to the former. It may be cast with the greatest ease, and is best melted without fluxing. It is slightly magnetic. Sulphuretted hydrogen has no effect upon it. Neither concentrated nor dilute nitric acid (if cold) act upon it; nor does dilute sulphuric acid affect it. (Its proper solvent is hydrochloric acid.) Vegetable acids do not change it. It is not found native in the metallic form.

Alloys of Commercial Importance.—With tin and zinc, brittle and easily fusible alloys are formed. With cadmium, it yields a malleable alloy. With a small proportion of silver, the malleability of aluminum is completely destroyed. An alloy containing 3 per cent. of silver is adapted to casting ornamental articles, and an alloy containing 5 per cent. is used for knife blades. With iron, aluminum unites in all proportions, affording hard, brittle alloys, and those of surprising strength and tenacity. With copper, a series of beautiful and valuable alloys are formed. Ten parts aluminum and ninety parts of copper, affords a hard, golden-colored bronze, having the tenacity of steel and the malleability of copper. In all cases the addition of aluminum increases the fluidity of molten metals, and lowers their fusing points. When aluminum is fused with boracic acid, at a high temperature, the boron separates in transparent red or yellow crystals, which in lustre, refractive power, and hardness, rival the diamond.

This metal possesses all of the desirable features of all other

metals, and none of their defects; and while many of its valuable attributes have been recited, they form but a portion of those possessed, and serve to indicate fairly well the varied uses and the marked innovations which will attend its common use.

Uses.—The manufacture of optical instruments, soldiers' accoutrements, medals, coins, and culinary utensils. In the manufacture of all articles demanding lightness combined with strength, to which iron and steel are now applied. In the manufacture of all such articles as are now made of tin, tin-plate, pewter, brass, copper, zinc or lead. To the construction of bridges, houses and ships, and to that of many things now made of wood. In the founding of metals, etc., etc., and the making of alloys, the use of which is no less important. Aluminum bronze, above described, tested by the war department at the Watertown arsenal, was reported as having a tensile strength of 72,000 pounds per square of cross section, and an elastic limit of 33,000 pounds without permanent set. An alloy, $3\frac{1}{2}$ per cent. of aluminum, $33\frac{1}{2}$ per cent. of zinc and copper, showed a tensile strength of 82,500 pounds and an elastic limit of 65,000. An alloy composed of aluminum and small quantities of nickel and copper, possessed a tensile strength of 111,000 pounds. The addition in small quantity of aluminum nickel alloy composite lowers the melting point of German silver, bronze or brass, and yields bright, sharp castings. The addition of aluminum nickel alloy, in minute quantity, to a crucible of wrought iron or steel, increases the fluidity, and affords good sound malleable castings, devoid of air-holes or sponginess. Country shops and small foundries can now, by means of these alloys, make their own castings, as the heat required is of easy attainment, and metal scrap everywhere abounds. Aluminum, $97\frac{1}{2}$ per cent. pure, is now offered by a Kentucky firm, in 100-pound lots, at 60c. per pound. It is only a question of time when it will be offered at 20c. per pound. When such point is reached, numbers of new industries will spring into being, greatly to the advantage of mankind.

Ores and Source of Supply.—Among the ores of aluminum

(but not so used) occur a number of beautiful gems. The ruby, the emerald, the sapphire, and the topaz, are silicates of aluminum, as is also corundum and emory. All clays, contain this metal, as do many rocks. One-fifth of the earth's crust is supposed to contain aluminum. Until quite recently the source of the commercial supply of metal was derived from cryolite, "a fluoride of aluminum and sodium," a mineral found in workable quantity, near the coast of Greenland, where it can be mined but three months of the year. Vessels engaged in its freightage can accomplish but one trip each season. This inaccessability of cryolite, quite materially enhances the value of the vast deposits of bauxite "discovered by Dr. J. C. Branner, State Geologist," near Little Rock. The limited areas of the deposits, known in Georgia and Alabama, coupled with the fact that as yet no other deposits of this ore has been discovered in the United States, still further intensifies the importance of Dr. Branner's discovery, as, through the presence of these deposits, and those of choice high-grade kaolins, "also an ore," it is possible and probable that Arkansas will become the chief center of the aluminum industry, and those dependent upon it.

DESCRIPTION OF THE ORES OF ALUMINUM.

Topaz.—Colorless, white, blue and pink; fracture, basil; lustre, vitreous; hardness, 8; specific gravity, 3.5; composition, a fluor of aluminum.

Such description will be confined to those substances which are worked as ores. Cryolite (a fluoride of sodium and aluminum), color, white to black; clearage, basil, perfect; lustre, vitreous; hardness, 2.5; specific gravity, 3; fusible in the flame of a candle. Remarks—A highly valued source of aluminum and soda.

Bauxite.—Color, white, brown, red; lustre, dull; soft; specific gravity, 2.55; viscular, spongy like.

Analyses—Dr. J. C. Branner (Official Report).

	(No. 1.)	(No. 2.)	(No. 3.)
Silica	13.13 per cent.	3.34 per cent.	11.48 per cent.
Aluminum	55.54 " "	58.60 " "	37.62 " "
Iron oxide (ferric)	6.08 " "	9.11 " "	1.83 " "
Water	28.99 " "	28.63 " "	28.63 " "

Remarks—Of vast commercial importance as a source of aluminum, alloys, alumn, alumnite of soda, and other salts of vital importance to medicine, and the dyer of clothes, fire brick, and furnace linings.

KAOLIN.

Kaolin.—Color, white, grey and brown, lustre, pearly; hardness, 1; specific gravity, 2.5; compact, fracture; subconchoidal.

Analysis—Dr. J. C. Branner.—Silica, 48.87 per cent.; alumina, 36.54 per cent.; iron (ferric oxide), 0.98; lime, 0.19; magnesia, 0.25; water, 13.29. Total, 100.

Remarks.—While not so good as the preceeding, as an ore, it is one of the most valuable. It is the material of the porcelain manufacturer, and a valued source of refractory brick and furnace linings.

Smelting.—The rapid advancement in metallurgical methods has been productive of unexpected but important results. It is now possible to produce aluminum alloys in a plant as simple and inexpensive as that of a small foundry. The requisite knowledge is easily attained and applied. No field of investment offers greater safety or profits. Small electric plants now reduce aluminum from its ores with facility, and as the product lowers in price the demand increases.

Asphaltum—(Bitumen). The occurrence of this mineral, on Clabber Creek, one mile from the Morning Star mine, is reported by Mr. E. V. M. Powel. The property is owned by J. H. Bethune, *et al.*, of St. Louis. Occurs in liquid form, filling cavities in magnesian limestone, in which crystals of bitter spar are abundant.

ANTIMONY—(STIBIUM.)

Genesis, Ores, Reduction, Uses, Importance.—This metal, sometimes found native, is of silvery whiteness, and highly crystalline texture. When broken the exposed surface exhibits facets of great beauty. It is hard and extremely brittle, tarnishes but little on exposure. Exposed on ignited charcoal to a current of oxygen gas, it burns with great brilliancy, evolving white fumes of oxide of antimony. At a temperature of 800° Fahr.

it fuses, and at a white heat gives off copious white fumes. If removed from the heat it remains fluid for some time, with continued evolution of fumes. If when molten it is dropped upon a smooth surface from the height of a few inches, it separates into numerous globules, which dart off in various directions, the line of travel being marked by a whitish trail. Should the surface be a sheet of paper, the progression is seen to be a series of leaps. The propulsive force is the result of the cooling of the metal at the point of contact, and the expansion of the metal in consequence. The long continued fluidity of the metal when in the melted state, the expansion of the metal when cooling, whereby the impression of the mould is clearly taken; the hardness an admixture gives other metals, and the increased fluidity conveyed by it to them, renders it peculiarily adapted to the making of alloys, intend for castings. In consequence it has an industrial and commercial value of no little importance.

In oriental countries, from an early period in the centuries, a sulphide of this metal under the name of alkahol, found extensive use as a pigment for the eyebrows, the application to which, gave an increased brilliancy to the eyes.

The star-like appearance of the metal when, permitted to cool in the crucible, was regarded by the alchemists as being a token whereby through its instrumentality they would achieve the transmutation of metals, or discover the philosopher's stone. In their efforts to acquire these supposed secrets of nature, the alchemists discovered several antimonial compounds, and seemingly were acquainted with the physiological effects of antimonial compounds when taken into the system. The first mention of this metal occurs in the writings of Basil Valentine, A. D. 1460, since which time it has in some form or other formed a commercial commodity.

Ores.—Several oxides and one sulphide of this metal occur in nature and are properly ores of the metal, but because of their very limited occurrence they are not so regarded from a commercial standpoint. The native sulphide is the source of the commercial supply of metal. Of this there are two forms,

the one, stibnite, is massive and columnar in structure, the other antimonite, is dark in color, rather more fusible, and of a plumose structure. Both kinds are fusible in the flame of a candle. Heated in closed vessels, the sulphide distils over unchanged, and is by this means separated from earthly impurities. The educt is known in commerce as regulus of antimony. This product has a stellated appearance through the interlacing of the long acicular crystals. Bearing in mind what has been said, the description of the sulphide will suffice here. Stibnite (antimony glance), color, lead to steel grey; streak, (*i. e.*, color of mark made on a hard, white surface), lead grey; lustre, metallic; prismatic and crystalline form; hardness, 2; specific gravity, 4.5.

Antimony occurs also, quite abundantly, as a constituent in certain ores of silver, lead, bismuth, nickel, copper, zinc and iron. Such ores, while depreciated in value as ores of those metals, by its presence, are of such richness in their contain-diture of silver as to be regarded and treated as ores of that metal.

Deposits of Antimony occur in Hungary, France, and a few other continental localities. In several localities in the United States. The largest, most extensive deposits of high-grade ore are those of Southwestern Arkansas.

Reduction, or Metallurgy of Antimony.—The smelting of antimony ores is of extreme simplicity, and does not require the expenditure of a fortune in the erection of the smelting plant. Wood and charcoal are satisfactory fuels. The furnaces are simple in form, inexpensive, and require but little space. "In view of the difficulty of clearly explaining the method of construction, without suitable illustrations, such explanations will not be attempted." The ores "first reduced to small pieces," "where containing silicious or earthly matters," are after warming, charged, "the large pieces first," into a crucible or vertical retort, through the bottom of which is an opening corresponding to a like opening in the floor of the furnace upon which the crucible stands. The space under this floor, is a chamber, having no communication with the furnace fires. In

this chamber is placed an earthen vessel to receive the educt from the one above. The cover is luted on the upper crucible and the furnace fired. A charge of 500 pounds is run off in three to four hours with a consumption of twelve to fifteen cubic feet of wood.

The product from this operation, or ores free from gangue, are then broken up, mixed with 25 per cent. of fine charcoal, and the sulphur eliminated by careful roasting in a reverberatory furnace. The complete oxidation of the sulphide being obtained, it is mixed with 22 per cent. of finely broken charcoal "which has been saturated with a strong solution of carbonate of soda" and charged into a retort arranged as the first, or into the body of a small reverberatory, constructed in accordance with the principle of the retort furnace. The use of lime and iron, in order to effect the reduction at one operation, is detrimental to the character of the product, the quantity of iron taken up by the antimony unfits it for many purposes.

Uses.—The extreme brittleness of this metal prohibits its use alone, and it is therefore applied to the fabrication of alloys, a use to which it is well adapted by its peculiar characteristics. Of the alloys of which it is a component part, the following are the most important, viz.: Type and stereotype metals, britannia metal, toy metal, babbit metal; used in the casting of bells, greater hardness and brilliancy is had as well as an increase in the volume of sound; used in the alloy for making metallic concave mirrors, greater strength, and a metal susceptible to a finer polish is attained; used in the casting of cannon balls, greater solidity is had as well as increased facilities in casting. The metal also finds important application in the preparation of medicinal compounds. It is the source of a series of brilliant and durable paints, and is used in pyrotechnics.

The opportunities offered in Arkansas for the founding of such industries, as are here enumerated, is unexcelled. All the requisites for the construction of furnaces, etc., fluxing, making of babbit, are present.

COPPER—GENESIS—ORES—USES, ETC.

Copper is of a warm, rich red color, and is the only red colored metal known except the rare titanirum. It fuses at 1994° Fahr. of heat, and at an intense heat volatilizes. Ignited in oxygen it burns with a intense green colored flame; is but little acted upon by exposure to moisture or atmospheric agencies. It is soft, ductile and malleable; and may be wrought into any desired form by hammering. In tenacity it ranks next to iron, and is one of the best conductors of the electric fluid. It acquires temper by rolling or hammering and may be again softened by heating and plunging into water. Copper is found native in certain localities in Europe, South and North America. The largest deposit of native copper known occurs in the Lake Superior region, where it is found in massive and arborescent forms, often superficially coated with silver.

Genesis—The occurrence of this metal in large masses in the metallic form, its great beauty and ease of working into desired forms, must early have attracted the attention of man, and led to its utilization. Of the period in which it first came into use we know nothing. Known and used from the most remote times, probably long before the birth of Tubal-Cain, althongh sacred history is silent upon the subject. It is evident that at a time coeval with this antediluvian artisan, its use had entered largely into the national economy and was extensively used in the manufacture of weapons, domestic utensils and ornamental articles. During the period indicated, copper is no where mentioned; it is brass only which is spoken of; sword blades and cutting instruments found in Herculaneum are invariably of bronze. This brass is found by analysts to consist of copper and tin with very small quantities of other metals present, as impurities, and is that now known in commerce as bronze. It is recorded that a copper mine on the Peninsula of Sinai was extensively worked by Cheops Chefu, in the fourth dynasty. No doubt can arise as to the smelting of copper ores by these ancient metallurgists. That their methods

of reduction were tedious, laborious and imperfect, is probable, but that they were adequate to the reduction of copper and tin ores, is fully demonstrated by their product—bronze. The Syrians and Phœnecians, were, as appears from various records, and the large quantities of bronze which they manufactured, extensive dealers in copper.. The ancient Greeks procured their supplies from the Isle of Cyprus, which, with Rhodes, continued for a considerable period of time to be the emporium for this metal. During the middle ages copper was sometimes used as a covering for houses of the better sort, and scenes were engraved upon copper plates. With the alchemists copper was represented by the symbol of Venus, and so called, not so much on account of its lustre and beauty (it being by them considered an imperfect metal), but from the facility with which it united to and was changed by other bodies. The use of this metal forms a chapter in the history of ancient Mexico, and in its future reading the origin of that people may yet be determined. It is only during the past eighty years that the mining of this metal has been prosecuted with energy, but the demands of commerce now press it forward with increasing vigor. Some species of copper ore contain such quantities of gold or silver, or both, as to be more valuable for their content of these metals than as copper ores.

Commercial ores of the region—The following sulphides of copper are easily recognized by their color and brittleness:

Chalcopyrite consists of sulphur, iron and copper; it is brass yellow in color, and makes on a hard white surface a green black mark.

Bornite, consists of sulphur and copper. In color it is bronze yellow, with a more or less abundant tarnish of a purple color. It makes a black mark.

Chalcocite, is steel grey in color and affords a grey mark.

Covellite, is indigo blue to black in color, and has the lustre of glass.

Cuprite, is of a red color, earthy to hard. It makes a red to red-brown mark.

Melaconite, is soft and earthy to hard, and metallic. It is black in color and makes a black mark.

The carbonates of copper—malachite—the green carbonate, is fibrus in structure.

Azureite is more or less deeply blue in color.

Quite a number of other species of copper ores occur in this or other regions in the State, but as the quantity is limited, and such would if worked speedily give place to those enumerated, which form the base of our commercial supply. It is not considered necessary to describe them.

Reduction.—The reduction of the oxides and carbonates of copper is easily and cheaply effected in a furnace of simple construction. The reduction in the furnace of the sulphides, is of far greater expense and difficulty, being accomplished only through a series of processes which demand skill and experience in their execution. Fortunately for the prosperity of the region, this class of ores are reduced with facility by means of any one of several processes of lixiviation, which, while effecting the extraction of the copper, permit also the saving of such increment of gold or silver as may be present in the ores. There are several by-products resulting from this process of reduction of no little importance, which quite materially increase the profits. Plants adapted to this method of reduction are simple in construction and inexpensive. Materials and other requisites are abundant and easily available in the immediate vicinity of desirable sites. A no more profitable industry offers than this.

Uses.—The metal is utilized in the manufacture of dynamos, batteries, sheathing of ships, numberless domestic utensils and ornamental articles of wire and rods, as conductors of the electric fluid, coins, electro-plating, engraving and other important uses, as the beautiful aventurine glass, "the brilliancy of which is due to crystals of metallic copper." Many of its alloys are of more importance and have a wider range of application than the metal.

Gold and silver coins and jewelry are hardened by it. Brass, bronze, gun and bell metal, German silver, and aluminum

bronze, are well known alloys. Dyes, paints, medicinal preparations and chemicals are also afforded by it. In the manufacture of sulphate of copper or the founding of alloys, a fortune awaits those who first found such industries in the State.

COBALT—GENESIS—ORES—USES.

So far as now known, the cobalt ores of this State are of no commercial importance. The character of the ores and the limited manner of occurrence, prohibits their being put forward as a resource available as the basis of a profitable industry. The possibility of the occurrence of workable deposits, however, renders a brief description of the metal and its more commonly occurring ores desirable.

Cobalt, is a metal of a steel grey color, with a pinkish tinge. It is by no means brilliant, but is susceptible of receiving a high polish. It is not found in the metallic state. The form of the metal varies, and is due to the temperature employed and the manner of reduction. It is seen in the form of plates sometimes in granulated form, and occasionally in that of fine fibers. It has no magnetic properties. Atmospheric agencies affect it but little. The difficulties attendant upon its preparation, and the peculiar properties of the metal, do not admit of its use in the metallic form.

Genesis.—It is hardly probable that this metal was known earlier than the fifteenth century. A substance then known as cobalt was used as a coloring for glass. An examination of this substance led to the discovery by Brandt, in 1733, "a Swedish chemist," of a new element, to which he gave the name formerly applied to an ore of the metal. The miners regarded the ores of Cobalt with suspicion, believing that such resulted through the agency of the evil one in his efforts to mislead them and render their toil unprofitable; and it was once a custom in the church in Germany to offer prayers for the protection of miners and their works from *cobalts* and spirits.

Ores.—Smaltine, is tin white in color, granular and uneven in structure. It is composed of arsenic and cobalt. This ore occurs in some localities associated with copper and silver

ores. Black oxide of cobalt is blue-black in color and earthy in form, and is usually found associated with manganese ores. Arsenate of cobalt, is of purplish pink color, and occurs incrusting other metals and also in " kidney form " masses. Cobalt also occurs in some species of iron, manganese and nickel ores, and is so found in this State.

Uses.—The various preparations of cobalt are chiefly used for painting on porcelain, coloring glass and enamels; in the manufacture of imitation gems, as a paint; also to counteract the yellowish tint of newly finished lawns, laces, etc. The chloride, nitrate and sulphate of cobalt are used as sympathetic inks. Characters written with a quill pen, using them as inks, are invisible until the paper containing them is warmed. They then become blue and visible, to fade away again in a little while. The proto-nitrate is a valued reagent in the laboratory. All substances containing cobalt, if fused with glass or other fusible silicate, with addition of borax or with this latter alone, affords a glass of an intense blue color. The coloring power of the oxide of cobolt is so intense that the one-twenty thousandth communicates to a pure white glass a perceptible azure blue tint. By various processes, too tedious to here describe, the oxide of the metal is procured for the after-formation of smelt, a fusible and deeply-colored glass, which serves as the vehicle for the introduction of the coloring matter into other substances.

CADMIUM—GENESIS—ORE—USES.

This metal has the color of tin, and nearly the same degree of hardness. It is very malleable and has a density of 8.7. It is not found native. At 460° Fahr. it melts, and at higher temperature passes off in vapor. It is but little acted upon by exposure to the air, but if intensely heated burns with the evolution of brownish colored fumes.

Genesis.—It accompanies the ores of zinc, and, being more volatile than they, passes over first, as vapor, when zinc ores containing it are subjected to distillation with charcoal. Calamine is usually richest in this metal, which was discovered by Stromeyer in 1817.

Ores.—Greenockite (sulphide of cadmium); color, orange to honey yellow; structure, prismatic; hardness, 3 to 3.5, about that of jack; lustre, adamantine.

Occurrence.—In some varieties of zinc blends, also in samples of carbonate and silicate of zinc, from Rush and Water Creeks, Marion County.

Uses.—The principal use of this metal is in the manufacture of certain alloys. It has a limited use in chemistry, photography, and other technical arts.

GOLD—GENESIS—USES.

Gold is a rich yellow metal, of brilliant metallic lustre. In ductility, malleability and tenacity, it exceeds all other metals except aluminum. It has nearly the softness of lead, and is the heaviest of all metals except platinum and iridium, its specific gravity being 19.5. It is unacted upon by atmospheric agencies, moisture or rust. It occurs only in the metallic state, and then never pure, it being alloyed by silver, copper, or platinum and its associates. It is found in quartz veins, traversing various formations; in gravel-drifts, of glacial origin; in the sands of streams traversing, or having source in, auriferous formations. In veins it occurs in spangles, shots, wires, stringers, arborescent, incrusting, in crystals variously modified, and in solution in the waters of some mines. In gravel and river sands, it is found in fine dust, grains and nuggets, which are rounded by attrition. More sparingly, it occurs in pyrites of iron, telluride, silver, manganese, copper, lead, zinc, and common iron ores. It is of wide distribution, being found in all quarters of the globe, in greater or lesser quantities, most frequently in insufficient quantity to repay cost of extraction. From its nature, and method of occurrence, gold was probably the first metal known to man. In the writings of the earliest period of the most remote times mention is made of it in such manner as indicates a knowledge of it and its uses in time preceding. In the Book of Genesis we read that in the land of Havilah "there is gold, and the gold of that land is good." Other occurring passages demonstrate the proficiency of the

metallurgists in the refining of gold and silver in the time of Moses, and the attainment of knowledge of no mean order.

In the cycles of succeeding times the light of ancient learning was overwhelmed by the darkness of the middle ages. A flickering flame, nursed by Arabian hands, was revivified by the alchemists and urged into a blaze, the light of which illuminates our time. By the alchemists, this most precious of metals, "so highly esteemed because of its rarity, beauty, weight, unchangeable character, and the ease of its fashioning into ornaments, or adapted to the purpose of exchange," was esteemed the only perfect metal. All others, were to them, imperfect, undeveloped, or diseased forms of gold. And they sought for means or media by which to effect transmutation of the baser metals into that of the perfect form. Failing in this, they left to us various valued forms of apparatus and knowledge in their use, which has resulted in such productions as gratify our needs, affording conveniences and comfort not attainable by gold alone.

With few if any exceptions, the celebrated mines of ancient days are now unknown; even the regions of their locations have passed from memory. The mines of Solomon, of Hannabal, of the Incas of Peru, and the emperors of the Mexicans, are now only known, to have been. In a pure state gold is too soft for the purpose of coinage, plate or jewelry. The necessary degree of hardness is attained without injury to the color by alloying it with copper and silver. A single grain of pure gold may be extended over 56.75 square inches of surface, or drawn out into a wire five hundred feet long. Its fusing point is at about 2006° Fahr. When submitted to the action of a powerful galvanic current, it enters into fusion and gives off metallic fumes.

Substances Mistaken for Gold.—Marcassite (pyrites of iron), brittle, heated on the fire gives off sulphur fumes, becomes red when cold, strikes fire with steel; chalcopyrite and other sulphides of copper, are brittle. Mica, after heating with nitre, loses color.

ORES OF GOLD.

As before stated, certain ores of other metals are rich in their contai:nditure of gold, and are utilized as a source of supply. These, however rich in gold they may be, are not ores of gold, nor is the quartz or other rock which may enclose it. Ore, is a metal that is in chemical combination with some other element, or, as we say, mineralized. Gold does not so occur. If present in such ores, it is as gold, mechanically enclosed. Where found native, gold is invariably alloyed with silver or copper.

Sources of Supply.—The gravels, sands and veins already described in Southwestern Arkansas, is a region bordering on the Cossatot and Saline Rivers, in which gold may occur in quantity; as yet, no workable deposits are known.

Uses.—As a medium of exchange; in the manufacturing of ornamental articles; in electro-plating; as a pigment in porcelain painting; as a source of choice purple dyes; and in numerous other applications of lesser note in chemistry and medicine.

Reduction.—The simple melting of gold is not attended with difficulty. And so far as the miner is concerned, is not necessary, as for his gold, whether in dust, bars, slugs, or other forms, he can at any time obtain its value in money. In the refining of gold and silver, knowledge and skill are requisites of success.

The recent legislation on the silver question will prove productive of increased activity in gold mining, and effect the reopening of old mines and the discovery of new ones. An incalculable advantage occurs to this branch of the mining industry in consequence of the act.

IRON—GENESIS—ORES.

Iron, is of a bluish-gray color, and perfect lustre, which may be heightened by polishing. Of the ductile metals, possessing both ductility and malleability, it is the hardest. In tenacity it exceeds all metals "except aluminum." The character of its fracture is dependent upon the method used in its production,

and is either granular or fibrous. The degree of heat required for its melting varies somewhat, because of the presence of sulphur, phosphorus, silicon and carbon, the presence of which lower the melting point, which is at about 3000° of heat. Before the fusing point is reached the metal assumes a pasty form, in which state two separate masses may be united into one homogeneous mass. Iron and nickel are the only metals which are strongly magnetic at ordinary temperatures. Steel is simply a carbide of iron.

Native Iron—Is almost pure white in color, and resembles silver more than ordinary iron. It is softer and tougher, and permits shaping, when worked cold, into more intricate forms than the product of the furnace.

Genesis—The use of iron began in remote ages, of which there is now no record. Whether its first use was the result of the accidental discovery of a mass of native iron, or of the kindling of a fire upon a bed of carbonate of iron, we do not know. That iron would have been produced by the latter cause is, to say the least, very improbable. In the first reduction of the ore quite an advance in the knowledge of mechanical arts is implied, inasmuch as the crude mud furnace and goatskin bellows of the African metallurgist embodies the same principles as those gigantic structures of our erection, and presupposes, in the erection of the furnace and the adaptation to it of a blast, the requisites essential to the reduction of the ores, and further, such knowledge of the character of ores as permitted the selection of those ores which afforded a malleable product by simple smelting. Moses tells us that Tubal Cain, the grandson of Cain, Adam's son, wrought in brass and iron. Job says, iron is taken out of the earth. This metal is referred to by the Scriptures as being in common use for the fabrication of weapons and manufacturing instruments.

Homer mentions that a mass of iron was awarded as a prize in the funeral games given by Achilles in honor of Patrochus, which is indicative, or rather, demonstrative, of the scarcity of iron, and the esteem in which it was held by the ancient Greeks.

"Then hurled the hero, thundering on the ground
A mass of iron—an enormous round—
Whose weight and size the circling Greeks admire,
Rude from the furnace, and but shaped by fire."

Pliny, in his natural history, has much to say relative to the manufacture of iron, and the occurrence of its ores.

Large masses of metallic iron have fallen upon the surface of the earth in various regions of the globe, and are termed meteoric irons. They are known by the presence of nickel, which does not occur in the iron of terrestrial origin, and by the peculiar lines observable when etched.

Iron is diffused throughout nature. It not only exists as a constituent in a vast variety of minerals, but is so constantly present as an adventitious mixture in nearly all mineral substances, that in the analysis of an inorganic substance the chemist seldom fails to detect traces, at least, of its presence. In most bodies, of both the animal and vegetable kingdoms, it is likewise present in some form or other. No other metal, as yet, can compare with it in utility. It was the lever which lifted the human race from the depths of barbarism to the advanced state of the present civilization, and now forms the foundation which sustains it.

Ores.—Magnetite (lodestone) occurs crystallized and massive, is of a deep black color, sometimes with reddish coating; compact, density, 5.5; brittle, affords a black mark, strongly attracted by the magnet; often has polarity; the best ore of iron.

Hematite, occurs crystallized and massive. Color, steel-grey to black, red; gives a red mark; lustre, earthy to metallic; very hard. There is an extensive series of seemingly different ores under this head, but such differences are simply due to variation in form; a good but somewhat refractory ore, and valuable.

Limonite, occurs crystallized, massive, stalactitic. Color, various shades of yellow; very soft to hard, makes a yellow mark.

Carbonate of iron, occurs massive, crystalline and in lenticular globular and platy masses. Color, light grey to nearly black; pearly lustre to dull earthy. When crystallized may easily be mistaken for a carbonate of lime.

Occurrence.—The above named ores occur of remarkable purity in deposits more or less extensive in other portions of the State. Ores, two and three, occur widely distributed in this region. The deposits are not of such character as to prove a satisfactory basis for iron smelting. They will, however, afford an abundance of choice, dark colored ochers, suitable for pigments, fluxing material and polishing powders, and are worthy of attention, the more so, as in intimate association with them, zinc or lead ores are found.

Pyrites of Iron.—There are three distinct kinds of this mineral, all of which have a brass to golden yellow color, and metallic lustre. They are very hard and brittle, of high specific gravity, and give a black mark. They are never anywhere used as iron ores. Some forms contain gold in quantity, and in such cases they are treated for its extraction. They are also used as fluxing to effect the reduction of the ores of certain metals. Their greatest value is due, however, to their being a valued source of sulphur in the manufacture of sulphuric acid, than which there is no more important chemical, there being few, if any, industrial pursuits or arts in life into which it, or some one or other compound of it, or one prepared through it, does not enter. The residue, after the extraction of the sulphur, finds use as an important pigment. When these substances are not utilized in such manufacture they are used in the manufacture of alum, sulphate of iron (copperas). The extensive deposits of these substances afford a most desirable basis for the erection of works adapted to their utilization.

Uses.—The civilization, wealth and refinement of a people can be determined by a knowledge of the extent and varied uses to which they apply iron and its derivatives. It enters into the structure of our homes, tools, clothing, utensils, medicines, and in fact, our very bodies.

LEAD—GENESIS—ORES—USES.

Lead is a bluish grey color, and when freshly cut of perfect metallic lustre. It is soft, malleable and ductile, and of inferior tenacity. Its specific gravity is 11.5. At a temperature

of 612°, Fahr., it fuses ; at higher degrees of heat it gives off vapors, but not so freely as to permit distillation. On exposure acquires a coating of oxide, but withstands perfectly the action of hydrofluric acid. Occurs, sparingly native.

Genesis.—This metal was known at a very early period in the world's history. Moses makes frequent mention of it. The alchemists regarded it as a valuable media in affecting the transmutation of metals, it being claimed by some that they had transformed it into silver. As silver is almost invariably present in lead, such claims seemed actually demonstrated to them on the finding of silver after the oxidation of lead, in which they had no reason for suspecting the presence of silver.

Ores.—Galena (sulphide of lead) is the source of the commercial supply of the metal. An extensive series of minerals occur in which lead is present in large quantity, but the deposits of such minerals are not extensive and soon give place to galena. A very large proportion of the silver of commerce is derived from galenas, which occur in greater or lesser quantity in all silver-producing mines in which any depth has been attained in the workings. Gold also occurs sparingly in this ore in some localities.

Galena occurs crystallized in the cubic form, is brittle, and when broken is sextile, the fragments being cubical in form. It is, when freshly fractured, of perfect metallic lustre, and of a lead grey to grey black color, with a bluish cast. In density it is 7.5. The mark afforded by it is blue black. Galena varies in form and crystalline structure, often when broken, appearing granular or platy. The ore has often a coating of white or reddish colored oxide. Found loose in the soil in large quantity.

Cerussite (carbonate of lead), color, when crystallized, red, blue, green and white. Dull to pearly in lustre. Brittle when massive. Occurs as an incrustation, also in irregular pieces. Color, red, yellow and intermediate shades—dull to glistening. These ores are those which occur here in workable deposits. The manner of their occurrence and the character of the deposits renders the mining of the ores a profitable industry, requiring but little capital.

Occurrence of Deposits.—Deposits of these ores occur on numerous tributary streams and branches of Sugar Loaf, Sugar Orchard, Sisters and Jimmy's Creeks. The heaviest development work of these localities has been done in the Short Mountains, the vicinity of Dodd City, Coffee Hill, Phil. Moore's, Sister Creek, also near Stone, Jimmy's Creek.

Utilization.—Several advantageous locations offer for the erection of lead smelting plants, in the product of which, is the basis for white lead works. The peculiar advantages possessed by this region render it, of all others, that best adapted to this enterprise, which offers to those who are possessed of small capital an opportunity for engaging in an industry which never yet has failed to enrich.

MANGANESE—GENESIS—ORES—USES.

This metal is greyish white in color; it is very hard and brittle, and so prone to oxidation that a covering of same hydrocarbon, is necessary to preserve it in the metallic form. It is fusible with great difficulty, requiring the highest heat of the blast furnace. Its specific gravity is 8. It is devoid of magnetic properties.

Genesis.—Braunstein, a black oxide of manganese, was long used under the name of magnesia-nigra by glass-makers for the purpose of neutralizing the green tint of glass. It was classed by mineralogists as an ore of iron until 1740, when Potts, showed that it often contained no traces of iron. A separate place was then assigned it in works on mineralogy as a peculiar earth. Subsequently Gahn proved the earth to be the ore of a metal, to which he applied the name of magnesium. Afterwards this term was used to designate the metallic base of magnesia, and the name manganese then became that of the new metal. No very great use other than that spoken of, until in 1785, when it was applied to use in the manufacture of chlorine, followed in 1839 by its introduction by Heath (an Englishman), into the manufacture of steel. This manufacture was by it revolutionized, rendering England, to a great extent, independent of Russian and Swedish iron in the manu-

facture of steel. From this its application to other purposes in manufactures and art, was more or less rapid, and it now finds use in the manufacture of steel, bronzes and other alloys; also in that of chlorine and other chemicals, pigments dyes, fluxing, etc., and many other important uses to which in the thus modified form it becomes applicable.

Commercial Ores.—Manganese, is of wide distribution, it being present in many soils, rocks and many organic substances. It is of frequent occurrence as a constituent in the ores of other metals, and its ores occurring in argentiferous regions are smelted for their silver contents. Many iron ores contain an appreciable quantity of manganese. Psilomelane, color; black, amorphous; specifiic gravity, 3.5 to 4.5; hardness, 5 to 6, that is, nearly as hard as quartz; affords a black mark. Pyrolusite, iron black in color; soft to very hard; about as heavy as the preceding; gives a black mark.

Manganite—Steel grey in color, prismatic in form; hardness, 4; specific gravity, 4.3; gives a red brown mark. The preceding are metallic in lustre wad; color, black to brown, dull, earthy, soft, massive, rather light; affords a black mark; some varieties contain cobalt.

Occurrence.—The occurrence of workable deposits of manganese in Marion and Boone Counties is very doubtful. Such deposits are, however, quite accessible and offer a basis for the establishment of the industries named. In the manufacture of chlorine, manganiferous salts, disinfecting fluids, paints, etc., a virgin field offers, in which, is every opportunity for the rapid acquisition of wealth. No chlorine is manufactured in the United States, and the presence here of all materials required in the manufacture, gives assurance of ability to compete with foreign manufacturers.

NICKEL—GENESIS—ORES—USES.

Nickel (sometimes found native) is a brilliant, silvery white, ductile metal, possessed of strong magnetic properties. It is somewhat harder than silver and rather more fusib than iron.

It has a density of 8.2, and is unchanged by atmospheric agencies.

Genesis.—This metal was first described by Chronstedt in 1757. But little use was made of it for many years, but during the last thirty years its importance has been fully recognized and its applications in the arts of life are now numerous and of great importance. It has a strong affinity for iron, an alloy of which, with nickel, compose the meteoric iron which has its origin in the regions of space. The affinity for cobalt is not less greater, and in ores of iron and cobalt it is frequently a constituent, and these metals occur likewise in the ores of nickel. In the separation or refining of gold and silver, the presence of nickel is a source of annoyance to the assayer, through the difficulty of expelling metals containing it. The name nickel, was applied to this metal by the old German miners as a term of detraction, they regarding it as a false copper ore.

Ores Occuring in Quantities of Commercial Importance.—The ores of nickel, with but few exceptions, are light in color and of metallic lustre, and bear some resemblance to those of cobalt.

Copper-nickel is of a light copper color of metallic lustre. It is brittle and usually occurs massive. The specific gravity is 7.4. On a white surface it affords a brownish red mark. It is generally found associated with the ores of copper, cobalt and silver. Nickel pyrites (Millerite), brass to bronze yellow in color, occurs crystallized in rhombohedial crystals, and in hair-like filaments. (It is that form of nickel ore most abundant in Arkansas.) Is easily mistaken for pyrite of iron.

Green oxide of nickel (genthite) occurs usually as an incrustation on other minerals, is nearly transparent, and of a deep green color, with vitreous lustre. Some varieties are found, black in color.

Uses.—The alloys of nickel are of vast importance in the arts of life. German silver, tutenag, aluminum nickel composite, aluminum nickel alloy, are the most important. An enumeration of the uses to which these alloys are applied is of

too lengthy a nature to be considered here. Large quantities of the metal are consumed in the electro-plating of other metals, a use to which the retention of lustre, brightness, and resistance to oxidizing agencies, perfectly adapt it. The salts of this metal find application in chemistry, and other avocations.

Importance of the Ore—Occurrences.—The presence of nickel ores in Arkansas, opens up to the founder of copper and zinc ores an avenue for the further enhancement in the value of their product, by manufacturing from it German silver and other alloys. This is no less true and important to the manufacturer of aluminum and its alloys. The establishment of no class of industries in Arkansas can effect such rapid development of her resources and wealth as can the founding of smelting and other metal-working industries.

SILVER—GENESIS—ORES.

Silver.—This metal is silver-white to a tarnished grey, sometimes of a reddish tint. The lustre is metallic, bright and shining; the streak, silvery white; hardness, 2.5 to 3; specific gravity when pure, 10.5; fracture, hackly, bright to splendent; is ductile, malleable, and of great tenacity. It is found native in the following forms: Platy pieces, spangles, dentiform, ramose, aborescent, wire and hair-like, penetrating or coiled, and crystallized in tubes, octahedrons and allied forms. In veins traversing the strata of the primary transition and secondary formations, associated with other ores and dessiminated in copper and galena in native form.

Genesis.—This metal was one of the first known to and utilized by man. Its occurrence in native form and in some ores of simple and easy reduction, rendered its procurance in quantity possible, by the use of such rude and simple appliances as was most probably devised for its treatment by man in the prehistoric ages of the world. The book of Genesis relates that Abraham, "who lived about two thousand years before the Christian era," was rich in cattle, in silver and in gold; that he paid 400 shekels of silver for a burial place for his wife. Joseph, the great-grandson of Abraham, was

sold by his brethren for 20 pieces of silver. The author of the book of Job, who is certainly a very ancient writer, says, "Surely there is a vein for the silver and a place for the gold." In the first book of Kings we find stated "that all the vessels of the house of the forest of Lebanon were of pure gold; none were of silver, for that metal was nothing accounted of in the ages of Solomon, and the King made silver to be as stones in Jerusalem." No less astonishing and incredible are the accounts given by the profane writers of antiquity, of vast treasures of gold and silver. In a description of the City of Ecbatana, by Polybius, it is stated that the beams, pillars and supports of the roof and portico of the palace were covered with gold and silver plates, and the tiles were of silver. The King of Lydia, Crœsus, is said by Herodotus and Diodorus to have presented to the temple of Delphi, 4000 talents of silver and 270 talents of gold, in value, about $15,000,000. Such examples of the vast accumulations are by no means of rare occurrence in ancient history, nor are such entirely absent from comparatively modern history. The power of theRoman Empire was shaken to its foundation by Hannibal, through the means of silver dug from Spanish mines, from one of which, the daily output was 4800 ounces of silver daily, This is but a tithe of the metallic wealth wrested from nature in times past; as a mighty river it flowed until the Roman Empire was swept from its place by barbarian hordes. It would be of interest to know what has become of these treasures, what of those of the Peruvian Incas, and of the Montezumas? Where is the source from which this wealth was taken.

Ores of Silver.—Silver glance (sulphide of silver), color dull, blackish grey; if freshly broken the lustre is metallic; can be cut in shavings with a knife; malleable; gives a grey black mark; hardness, 2; specific gravity, 7.2; easily mistaken for galena. This ore contains 85 to 87 per cent. of metallic silver.

Grey Copper (*tetra hedrite*).—This ore contains antimony, copper and silver; color, lead grey; lustre, semi-metallic to metallic; streak, dark grey; hardness, 3.5; specific gravity, 4.8; affords a grey streak or mark.

Brittle Silver (*stephanite*).—Color, iron black ; streak, black; hardness, 2.5 ; specific gravity, 6.25.

Ruby silver (*pyrargyrite*).—Color, red to black ; streak, red ; hardness, 2.5 ; specific granity, 5.8.

Galena (*sulphide of lead*).—See under lead. A very large portion of the commercial supplies of silver comes from this source. Very few samples of galena are found which do not contain some silver, the amount present varying from the assayers' trace, ½ ounce to the ton of ore. This, or any other ore that contains .005 of silver, is very rich. Where lead contains 2 to 4 ounces of silver to the ton, it is separated by the Pattinson process. Where 15 to 25 ounces, it is considered an ore of silver. The galena ores of this region are usually argentiferous, the content of silver varying from a trace to 67 ounces to the ton. Silver occurs also in ores of zinc, copper, iron and manganese.

The silver ores here described are only such as have been or may be found in this region. Of the uses and applications of silver it seems needless to write, as to most people they are well known.

ZINC—GENESIS—ORES—USES.

This metal is bluish white in color, of metallic lustre, which becomes tarnished on exposure to the air. The structure is lamellar and crystalline. The specific gravity is 6.8 to 7.2. It melts at 773° Fahr., and at higher temperature, it boils and volatilizes, and if air be admitted, burns with green light, and production of oxide of zinc. The metal is, under ordinary circumstances, brittle, but if heated to 250° Fahr., becomes malleable and may be rolled or hammered, and after cooling, retains its malleability. If subjected to 400° Fahr. of heat, it becomes so brittle that it is reduced to powder with facility.

Genesis.—The ores of this metal were known from a very early date, but in no instance has an examination of brasses, known tc have been produced to within a period of twenty years preceding the advent of Christ, revealed the presence of zinc as a constituent of such brass. About this time it was found that an admixture of cadmia, "a supposed earth," with

the copper ores, produced a golden colored metal, which they designated aurichalcum, esteeming it simply a purer form of copper. This mode of manufacture was that followed for a long period of time, when it was discovered that an admixture of tutia, "a residue remaining after the fusion of copper and cadmia," was also adapted to the manufacture of brass.

Zozimus, "a writer of the fifth century," states that to make brass, cyprus copper must be melted and powdered tutia sprinkled over it. According to Alburtus Magnus, the celebrated alchemist Hermes, taught that to make copper of a golden color, copper was to be mixed with powdered tutia, and melted.

About the middle of the sixteenth century, Alburtus Magnus made use of the term zinc by which to designate the educt from cadmia. But the principle in the earth, which effected the change of copper into brass, he knew as marcasita anuria. From this time until that of Paracelsus, "who was the first to characterize it as a distinct metal," it is probable that, through gradually developed facts, a more comprehensive knowledge of cadmia, tutia and other zinciferous substances was acquired, which lead, as a natural consequence, to the isolation of the metal. For some years after this event, the characteristics of the metal were practically unknown. Agricola, "who wrote in 1550, twenty years after Paracelsus," states that liquor candidus, or counterfey, was a product of the goslar, cadmia. And Fabricus, "who died in 1571," conjectures that stibium was what the miners called cincum, a compound which could be melted, but not hammered. From this it will be seen that for a long time after the recognition of zinc as a metal, a knowledge of its properties was meagre and confined to a few chemists, even these being prohibited by the edict of the Duke Julius from making or selling it, or making it generally known, as through it, it was generally believed that the transmutation of metals could be effected, and the coinage of the country thereby become debased. For a long time this metal was held in high esteem by the alchemists because of its supposed virtue in transmuting copper, and the

possibilities it possessed as a media through which the transmutation of other base metals into others, more precious, might be effected. Lives were devoted and fortunes dissipated in vain efforts for the achievement of this purpose.

Beckmann Keukell is supposed to have been the first to procure metal direct from calamine, "about the year 1741." Von Swab, "a Swede," obtained it by the distillation of calimine. In 1742, Watson states, in his "Chemical Essays," that a zinc smelting plant was established in England, in 1743, for the reduction of this metal. Others quickly followed, and in 1820, the metal was exported from England in large quantities. The utilization of the metal was chiefly in the manufacture of brasses, and has since continued to be largely consumed in this manner, but new applications for the metal is being constantly found.

ORES, OF ZINC.

The most important ores of zinc are the oxide, carbonates, sulphide and silicates. Only those varieties of ores which occur in this region will be here described.

Smithsonite (carbonate of zinc).—Color, white, greyish, greenish, to green and yellow; lustre, vitreous to pearly; hardness, 5; density, 4.5; brittle, easily frangible; fracture, uneven; sub-transparent; translucent; occurs, in reniform; botryoidal; stalactitic, incrusting; also massive; granular; earthy; the latter is the dry-bone of the miners. A perfectly pure carbonate of zinc consists of oxide of zinc, 64.8 per cent.; carbon dioxide, 35.2 per cent. Portions of the zinc oxide are frequently replaced by iron, cadmium, manganese, lime or magnesia. As less expense and difficulty attends the reduction of this ore, it is highly esteemed by smelters.

Analysis of Ores.

PROF. WM. ELDERHORST.

	(No. 11.) From Upper Silesia.	(No. 15.) Same region.	(No. 9.) Marion Co., Ark.
Oxide of zinc	27.02	61.97	65.467
Carbonic acid and water	26.63	10.32	31.454
Silica and insoluble silicates	16.56	18.79	1.512
Peroxide of iron	10.86	9.52	trace
Alumina, Lime, Magnesia,	19.72	1.67	1.067
	100.81	101.27	100.000

W. ALBERT CHAPMAN.

	(1)	(2)	(3)
	Crystallized Carbonates from Morhing Star mine, Marion Co., Ark.		
Oxide of zinc	63.65	64.75	61.40
Carbonic acid	34.55	35.25	35.40
Oxide of cadmium	.75	trace	
of iron	.50		1.20
Silica	1.00		
Lime, Magnesia, Alumina			2.00
	100.00	100.00	100.00

Numbers 11, 15 and 9, are the results, "as given by Prof. Elderhorst," of an examination of ores from various localities. Numbers 1, 2 and 3, are the results of an examination of samples from the Morning Star mine, by the author. No. 1 was of a rich, warm, yellow color. No. 2, was grayish in color. No. 3, was greenish in color, with dusy cavities, with red stains.

The above demonstrates the high grade character of the carbonate ores of this region.

CALAMINE—(SILICATE OF ZINC.)

Color, white, grey, with shade of blue, green or yellow color; lustre, pearly to sub-vitreous; translucent; hardness, 4.5 to 5; density, 3.5; affords a white mark; brittle; fracture uneven; sometimes pyroelectric occurs crystalized more commonly in stalactitic; mammillated, botryoidal forms also massive and granular; with difficulty distinguished by optical characteristics, from Smithsonite. When chemically pure, c

amine consists of 67.5 per cent. of oxide of zinc, 25.0 per cent. silica, and 7.5 per cent. of water.

Analysis of Ores.

SILICATES, FROM FOREIGN COUNTRIES.

	(Berzelius.) (1)	(Berthier.) (2)	(Smithson.) (3)	(Thompson.) (4)
Oxide of zinc	66.84	66.0	68.3	66.8
Silica	24 89	25.0	25.0	23.2
Oxide of lead Oxide of tin	0.28	....	...	....
Water	.54	9.0	4.4	10.8
Carbonic acid	74.45	....	3 3	....
	100.00	100.0	101.0	100.8

SILICATES, FROM MARION, BOONE, SEARCY AND NEWTON COUNTIES.

W. Albert Chapman.

	(5)	(6)	(7)
Oxide of zinc	62.20	66.50	67.35
Silica	23.00	24.	24.75
Protoxide of iron	.10	.50	
Alumnia	1.50	.75	.40
Lime	1.75	1.25	
Magnesia	.50		
Carbon dioxide	2.00	1.00	.10
Water	8.00	8.00	7.50
	100.05	102.00	100.00

The above numbers 1, 2, 3 and 4, represent the compositions of German, French and English silicates; 5, 6 and 7, that of silicates of this region. No. 5, is from the Andy George mine, on Buffalo; was massive, deeply fissured, lamillar in form. No. 6, was from Water Creek. No. 7, from the Morning Star mine. This ore, while not so acceptable to the smelter, is, nevertheless, a most valuable ore of zinc.

Hydrozincite "Marionite."—This ore, is the most valuable and desirable of the ores of zinc, both because of being of easier reduction and richer in its containditure of metal. It is quite probable that it will be found in this region in workable deposits. The following is an analysis of this heretofore rare species of zinc ore, by Prof. Elderhorst, who describes it as Marionite. It is quite certain that this species varies in com-

position, even when pure, and that the percentage of water present is due to manner of formation and lapse of time since the process of formation ceased:

Oxide of zinc	73.262
Carbonic acid	15.000
Water	11.080
	99.352

Description of hydrodrozincite.—Color, white grey, chalk like; earthy, lustre, dull to vitreous; hardness, 2 to 4; specific gravity, 3 5 to 4; streak shining to dull white; a decomposition product, occurs; earthy, massive, compact; in stalactitic, reniform and lamillar form; also incrusting other ores. Sometimes easily seperated in platy pieces.

BRANNERITE—A NEW ARKANSAS MINERAL.

"A pamphlet entitled, 'Natural Resources of Boone and Marion Counties, Arkansas,' published by Prof. W. Albert Chapman, assayer and mining engineer, of Yellville, Arkansas, contains the following description of a new mineral discovered by him in the northern part of this State, and named in honor of our State Geologist. The following is Prof. Chapman's description of this mineral:

"*Brannerite.*—On the property known as the Coon Hollow mines, situated in section 17, township 19, range 18, Boone County, Arkansas, an outcrop of two or more feet in thickness is seen in strata or ledge form. This outcrop has been stripped in several places and found to be quite extensive. An examination led to its acceptance by the writer as a new or undescribed species of zinc ore, and one, commercially considered, of some importance, both because of its occurrence in quantity and the possession by it of certain features having an important bearing on its reduction and utilization in the manufacture of oxide of zinc (or zinc white). So far as the writer is aware, this species of ore occurs in but two localities, the one being that mentioned, the other the Leader mine on Clabber Creek, Marion County, where it has been found very sparingly. Should future examinations by others verify those of

the writer, he proposes for this species the name of Brannerite in honor of the present State Geologist, Dr. John C. Branner, whose efforts to legitimatize the mining operations in the State has had much to do with the present advancement and assured stability of those interests.

Description.—Brannerite, "an anhydrous carbonate of zinc. Optical characteristics: Color, milk white; lustre, dull to slightly glistening; streak, white, powder, milk white; hardness, 5.8 to 6.2; fracture sub-conchoidal; specific gravity, 4.2, infusible; occurs massive, rough and deeply corroded, sometimes vesicular, coated with white pulverulent powder. Pyrognostic characters: In powder, in closed tube, a white sublimate, which, on intense heating, becomes brownish yellow; assay when hot, bright sulphur yellow; when cold, white. In open tube evolves carbonic acid gas. On coal, in oxidizing flame, appears green while the flame is directed upon it. Bright sulphur yellow when hot, white when cold. Moistened with nitrate of cobalt, and reheated, emerald green. On coal, in reduction flame, same reactions, and in both cases yields sublimate of white oxide of zinc. Fused with soda, opaque enamel, yellow when hot, white when cold. With borax, in both flames, colorless bead, which, when saturated and subjected to the action of an intermittent flame, forms a white enamel.

" *Chemical Characters.*—Soluble in cold dilute hydrochloric acid with residue of silica. Partially soluble in 12 per cent. ammonia. Precipitates as other zinciferrous compounds.

Analysis.

Oxide of zinc	74.2
Moisture	1.4
Carbonic acid	24.4
Protoxide of iron	.6
Silica	2.0
	10.22

" The limited time at disposal, this paper now being in press, has prevented a repetition of the analysis, and as there are reasons for supposing the iron and moisture present as ad-

ventitious matter in the assay material, no attempt will be made toward constructing a formula for this species from the above results. Such will be given in the succeeding issue of the pamphlet."—[*Arkansas Press*, October 19, 1889.

On working, "the outcrop described as being in Coon Hollow," was found to be a superficial coating of this ore. This, together with its occurrence in other like situations, proves it to be a resultant from the decompositions of other zinciferous compounds. It has, since the writing of the above, been found on the Bull Shoal Mountain, and on Wild-Cat Creek. A number of metallurgists and others have manifested much interest in it, and should a large deposit of it be found, it will prove of much profit to the owners. Ores of zinc are not stable in form, all being prone to decomposition and change of form, unless protected from the action of atmospheric agencies by a covering of water. In consequence, in ore deposits, all kinds of ore will be found in the upper workings, as also various combinations of two or more forms, such will give place to jack, when water is reached.

Sphalerite (*Zinc Blend, Jack, Sulphide of Zinc.*)—Color, white, brown, yellow, red, black, green, steel gray; hardness, 3.5 to 4; lustre, resinous to adamantine, transparent—translucent fracture; conchoidal, brittle; affords a white mark; specific gravity, 3.9 to 4.2; occurs crystallized in tetrahedral and dodecahedral forms with perfect cleavage; also massive, compact, botryoidal, fibrious and radiated; when pure, consists of oxide of zinc, 67 per cent, sulphuric acid, 33 per cent. It is very seldom found of such purity. In most samples, a portion of the zinc is replaced by iron, copper, silver or cadmium, giving origin to several varieties of this ore, as: Ordinary, containing little or no iron, color usually light; ferriferous, containing 5 to 12 per cent. of iron; color, steel gray to black, known as marmatite; when cadmium is present the ore is known as prizbramite, color of cadmiferous blend, is usually greenish or reddish yellow. The cuperous variety, is in color blue or green, quite often being coated with copper carbonate. Silver or lead may be present in any of the above species.

Argentiferons Blends.—Furnace assay (scorification). No. 1, gave 2 ounces of silver, per ton of ore, No. 2, gave 7 ounces of silver, per tou of ore. In the ordinary processes of zinc smelting no regard is had to the presence of small amounts of silver; it is lost. After the richness reaches a certain limit the ores are then looked upon as silver ores, and so treated.

Analysis of Ores.

(W. ALBERT CHAPMAN.)

	(0.)	(1.)	(2.)	(3.)	Berthus. (4.)	Jackson. (5.)
Oxide of zinc	58.25	65.75	61.50	64.60	61.5	52.0
Protoxide of iron	2.25	1.25	3.00	1.00	4.0	10.0
Oxide of cadmium	....	....	....	2.00	...	3.2
Oxide of copper	6.00	....	2.25	trace	...	....
Manganese	....	...	....	....	...	1.3
Sulphur	33.00	....	....	....	...	....
Silica	.50	33.00	33.25	32.40	33.0	32.6
Earthy matters	....	.....	.....	.....	10.5	00.9
Total	100.00	100.00	100.00	100.00	109.5	100.0

Numbers 1, 2 and 3 are quite common ores throughout this region. They are, as compared with 4, which is from New Hampshire, and 5, which is from England, of remarkable purity, both in constitution and adhering matters, and will command the highest price in any zinc ore market. Number 0 occurs in exposed situations in localities where copper, is quite abundant. It is black in color, dull of lustre, deeply eroded, very fine grained, with absence of cleavage lines; more frequently than not is coated with green carbonate of copper, is probably the base of aurichalcite (a rare mineral of no importance, as an ore.)

In various mines throughout the region, goslarite (zinc sulphate, or vitriol) occurs. It is white, pulverent, chalky like, has a peculiar taste. If found in commercial quantity would prove of great value to the owner, as it contains a heavy percentage of zinc oxide, and is soluble in water. Its source is, "as is likewise, that of the clays and other ore following" in the dissolution of overlaying ore beds, by means of carbonate waters. The author has found in the Leader mine, on Clabber

Creek, waters dripping from the roof charged with sulphate of zinc, and plastic masses of this substance in the White Eagle, on Rush Creek. Samples, have been brought in from other localities. The following clays, contain it in soluble form. The first analysis, is that of clay from the Leader, the occurrence of zinc in such clays being reported to E. V. M. Powell, "the then superintendent of the A. M. and I. Co.," by the author, April 12, 1889. The second, is by Prof. Branner, State Geologist of Arkansas. The proper method of extracting the zinc from such clays is by lixivation with water, subsequent evaporation, and crystalizing out.

Sulphate of Zinc—A Marketable Product.

	(1) W. Albert Chapman.	(2) Prof. J. C. Branner.
Silica	31.50	39.77
Alumina	12.20	8.62
Iron oxide	4.25	6.75
Zinc oxide	31.00	31.88
Lime	6.00	1.45
Magnesia	2.00	0.63
Sulphur	1.50	
Potash	0.05	0.84
Soda	0.05	0.36
Water and loss on ignition	12.00	8.46
	100.50	98.76

The following analysis, is that of what might be termed a sand carbonate. The sample is said, to have came from the Big Buffalo mine.

Silica	43.0
Oxide of zinc	22.0
Alumina	4.0
Oxide of iron	5.0
Lime	1.40
Magnesia	1.60
Carbonic acid	10.0
	1,000

This latter can hardly be regarded as an ore of zinc, the low percentage of metal present, and the difficulties of reduction, cost of transportation, etc., prohibit its treatment. With the exception of willemite, zincite, spinel and franklinite, all the

known varieties of zinc ores, occur in this region; later developments may unearth these. There are species quite common here, which are rare or unknown in other localities. That the zinc ores of this region are superior to those of other localities, the appended letter shows.

"MATTHIESSEN & HEGELER ZINC CO.,
"LASALLE, ILL.,
"November 20, 1889.

"*Prof. W. A. Chapman, Lead Hill, Boone Co., Ark.:*

"DEAR SIR—We have your favor of October 24th, in regard to zinc ore. We have found that all ores shipped from Batesville found such a ready market at such high prices, at and near St. Louis, that it is useless for us to try to compete for the same and pay the additional freight. We are now perfectly willing to leave that trade and the development of the mining properties to other parties *for the present.* It is too distant and inaccessible to us until railroads open that district.

"Yours, respectfully,

"H. ENGLEMANN,

"*Supt. Ore Dept, of Matthiessen & Hegeler Zinc Co.*"

Relative to the smelting of zinc ores, many crude and erroneous impressions prevail. For which reason, and that the smelting of such ores, while of not such easy reduction as those of lead, is not attended with difficulty, large expense, or other feature, which can render the reduction here either impracticable or unprofitable, a description of the process followed in many localities is given.

English Process of Reduction—Distillation Descensum.—Roasting furuace.—This is a reverberatory, ten feet in length by seven in breadth. The distance from sole to highest point of roof is about thirty inches, that of the fire bridge is eighteen inches. The stack is eighteen to forty feet in height, the furnace proper seven feet. It is constructed of stone, fire-brick and iron.

Use.—The principal use of this furnace is to deprive blend of its sulphur. The jack is broken into fragments the size of a small hickory nut, and charged into the furnace to the depth

of four to five inches, and constantly stirred during the operation, which requires ten to twelve hours for its completion. Carbonates and silicates are likewise deprived of moisture in this furnace, by the same method of treatment.

Reduction furnace.—This furnace is circular in form, and may be of such dimensions as desired. Tne bottom of the furnace is supported by pillars, two and one-half feet above the ground. In the center of this bottom the fire-place is made, and around it are disposed large crucibles, through the bottom of which are holes, corresponding with like holes in the bottom of the furnace. Iron pipes are passed through these holes, the upper end terminating a few inches below the mouth of the crucibles, and the lower end is immersed in a vessel of water resting on the ground. The pipes being luted in place, the crucibles are charged "in the case of previously roasted jack or carbonate," with a mixture of fine coal and ore. The covers of the crucible luted on, all being covered by a clay dome, having openings opposite each crucible, the furnace is fired. The zinc raises in vapor and passes down through the tubes, a charcoal plug preventing the passage of ore, into the vessels below. The metal there condenses Five distillations may be made in twelve days, in the course of which, in a furnace of four crucibles, eight to ten tons of ore is reduced, the educt being 35 to 40 per cent. of the ore treated. The average life of a crucible is four months. They can be readily made upon the ground. The stack is a continuation of the furnace, being of gradual taper from the base to the top. The height is from forty to one hundred feet. The author believes that he has been sufficiently explicit in this description to enable any one to realize the simplicity of the method, plant, etc , and also convince them that such plants can be erected at small expense, and profitably operated as can also, plants for the manufacture of oxide of zinc direct from the ore. The saving in freightage saved through shipping the metal is as 2 : 1. That is, roughly stated, the cost of shipping a ton of metal is one-half of that, of shipping the two tons of ore, which before reduction contained it. Other methods are in vogue for the reduction of

zinc ores, but all act upon the same principle, and are not better, and far more expensive than that given, which has been in use some two hundred years. The natural facilities of the region are peculiarly advantageous to the smelter of zinc ores, the manufacturer of zinc white "oxide." The location is also advantageous to the establishment of zinc plate works, etc.

STRONTIA.

A lustrous golden yellow metal, as hard as lead. Melts at a red heat; not found in metallic form. Its ores are celestite, the sulphide stronticinite; the carbonate, which is found in all colors, prismatic in form and of a hardness of 4. The nitrate and chloride "salts prepared from these ores," colors flame of a deep crimson red, and is used in pyrotechnics. A strata, white in color, of excellent quality, is found in the Morning Star Mountain, above Guthrie's. The writer made from this material, red fire equal to any obtainable in market.

BARIUM.

A silvery white metal, melts at a red heat; malleable as the preceding. In the metallic form as yet finds no application. Witherite, the carbonate, and heavy spar, the sulphide, are its ores, from which is derived a series of valued reagents and chemicals, a number of which are poisonous; used in pyrotechnics, affords a green flame. In some countries, the sulphide finds use as a source of sulphur; does not occur in this region. (For localities, see list.)

CALCITE.

Crystallized carbonite of lime, occurs in more or less extensive deposits throughout the region; also as the gangue stone of many mines. That found in the Crown Point mine, is transparent and contains parallel rows of minute prisms of sulphide of copper. Uses: Finds application in lime making, also lime cartridges for blasting; chemicals, as an adulterant of white lead paint, also as a flux in the smelting of metals, etc., etc. Of all colors, easily cut with a knife, breaks into rhombs.

LITHOGRAPHIC LIMESTONE.

Fine grained, even in texture, colors, buff, drab, grey. Found in several localities.

HYDRAULIC LIMESTONE.

A limestone "containing some alumina," which when burned forms a cement which hardens under water. The proportions of the constituent parts in different samples vary, seemingly without detriment to the product.

Analysis of New York Sample, (Dana.)

Lime	23.50
Magnesia	12.35
Silica	15.37
Alumina	9.13
Sesque oxide of iron	2.25
Carbonic acid	34.20

Which compare with the following, by

Samples from Satillo, Pa. Dr. McCreath.

Lime	14.120
Magnesia	9.571
Protoxide of iron	3.342
Alumina	14.066
Carbonic acid	24.592
Water	1.005
Silica	33.220

Sample from Jimmy Creek, Marion County. W. Albert Chapman.

Lime	22.
Magnesia	12.25
Alumnina	12.10
Silica	17.10
Sesqueoxide of iron	3.00
Water	1.20
Carbonic acid	33.50

The occurrence of stone well adapted to the making of cement is quite common. It is a decomposition product, resulting from the disintegration of other strata.

Tripoli (infusorial earth).—White, yellow, resembles chalk or clay; feels gritty when rubbed in the hand; scratches glass

when rubbed by it. Consists principally of the silacious shells of dictoms.

Uses.—To give body to nitro-glycerine in the manufacture of dynamite; more extensively as a polishing powder, of which there are many grades. Occurs in this region in large deposits in the form of a pulverent powder and soft, friable, yellow colored stone, both forms of which contain lime and alumina, and are peculiarly adapted to polishing tin and tableware, being possessed of grease absorbing qualities. From these coarser grades fine powder for polishing gold and silver can be had. Offers a good basis for a profitable industry.

Silica (quartz).—A strata of sandstone adapted to the requirements of the glass manufacturer is exposed in many places. Its value is dependent upon the absence of iron, presence of alkalis and easy fusibility.

Alabaster (a sulphate of lime).—Color, white, massive, easily worked; susceptible of taking a fine polish; finds extensive application in the manufacture of ornamental articles. Occurs with Mexican onyx in caves throughout the region; is a variety of gypsum, for which see list for localities.

Mexican Onyx (carbonate of lime).—Various colors in banded form; occurs only in caves, where it forms as stalactites and stalagmites; often of enormous size; sometimes entire caverns are filled by it; often occurs filling crevices and openings and then has the appearance of strata. In great demand for the manufacture of ornamental articles. Large deposits occur in numerous localities throughout the region. The quality and beauty of the stone gives assusance of good markets.

Marble (carbonate of lime).—The deposits, "more properly fields," of this stone occurs, covering extensive areas to a depth of many feet, often requiring no stripping in the working of the beds. Where traversed by ravines, the marble juts out as cliffs seventy-five or more feet in height. In such situations it can be quarried at a cost of ten cents per ton. The extreme beauty of the red variety, which is thickly set with

snow-white crinoids, which in the cutting assume all manner of geometrical forms, the effect is striking and peculiar.

Grey, pink, and delicate bluish gray marbles, also occur, as also limestone brecciated rock, in which irregular forms of deep red, snow white, pink, yellow and black colors are seen. Numerous other beautiful stones suitable for all building purposes, are found. Many of these deposits are easily accessible from White River. In quality the finer grades equal the marbles of Tennessee or Georgia and offer peculiar inducements for the establishment of works by marble workers. The stone can here be cut to standard sizes and shipped unencumbered by waste material. To such works a further profit would accrue from the cutting of alabaster and onyx.

Kaolin (a silicate of alumina), used in the manufacture of china. The inferior grades, for coarser ware, color, milk-white; soft, breaks with a conchoidal fracture, resembles chalk in appearance. A choice grade occurs in a deposit in Boone county. (For other localities, see list.) Would permit the founding of a profitable industry.

Talc (a silicate of magnesia) occurs here only in small quantities. Color, white, red, yellow or green; soft; easily cut by the finger nail; feels soapy; somewhat pearly in lustre; the red clays occurring in zinc and lead deposits and other silicates are talcose clays, but not talc; lime is in them, the predominatinating ingredient. No working of any magnitude should be carried on in them without timbering, as they close in without warning.

Quartz (massive form) occurs in all parts of the region. Color, white; hardness 7, an associate of ores in some deposits; has been mistaken for marionite (a zinc ore); quartz will scratch glass, marionite will not; heated to redness, marionite turns yellow, quartz remains white.

Onyx (quartz).—A few fine examples of this stone is found in the beds of streams; now is but little used in jewelry; color, milk-white and opake, and bluish white and translucent, alternating with each other; hardness 7; formerly used for cutting into cameos.

Jasper (quartz).—Color, red, yellow and brown, of various shades, opake; hardness 7. Of no value. Occurs as above.

Flint (quartz).—Color, grey, yellow, blackish; occurs in nodular masses; covered with a white chalky coat; fracture conchoidal; lustre glimmering to greasy, translucent on the edges, gives sparks of fire when struck with steel; scratches glass.

Nitre Earths.—White River is for many miles bordered by limestone bluffs, which rise from the water's edge to an altitude of two to three hundred feet. Extensive caverns are quite common to the formation. Numbers of these caves "occurring near the summit," contain vast deposits of nitre earths yielding two to four per cent. of nitric acid, and "after treatment" an ochreous residue "of a fine brown red color," well adapted to use as a mineral paint. From one such deposit "measuring 3000 feet in length by 500 in width, to which measurements those of numerous unexplored passages are to be added," 100 pounds of the earth was taken and delivered to the author for treatment by the method followed in working on a commercial scale. The product of such treatment, was eight pounds of crystallized nitrate of potash (quoted in market at 10½ cents per pound). This is equivalent to 160 pounds of nitre to the ton, which at 8 cents per pound would give $12.80. The ochre would now sell at 2¾ cents per pound, giving $8.25, or a total of $21.05 per ton of earth treated. The product of fine ochre will approximate one and a half tons to each ten tons of earth, and a coarser grade remain, which might, perhaps, find a ready market.

Process of Treatment.—The soluble constituents being leached out by means of water, the requisite quantity of potash lye is added to the water, from which, on boiling, the carbonates of lime and magnesia subside. The liquor is then evaporated to the crystallizing point, and then run into crystallizing pans. The ochrey residue is dried, heated to redness, and is then ready for the paint manufacturers.

Cost of Treating Ten Tons of Earth.

Mining and delivering to the works, 20 cents per ton	$ 2 00
Grinding and lixiviating, 75 cents per ton	7 50
Boiling, etc., fuel and labor, $2 per ton	20 00
Lye, leachings of ashes, 50 cents per ton	10 00
Packing and freight to St. Louis, $4.50 per ton	18 00
Total	$57 50
Product—1600 pounds nitrate of potash, at 8 cents per pound	$128 00
3000 pounds ochre at 2¾ cents per pound	82 50
Total	$210 50
Profit	$153 00

A plant of ten tons daily capacity, can be erected and put in operation for $1200. Stone for furnaces is on site; fuel to be had at the cost of cutting and hauling. The earth can be delivered by chutes to the works, the product thence, by the same means, on boats, to St. Louis.

Potash Works.—The commercial value of potash, and the extended list of chemicals of which it is the basis, attaches to this industry an importance, which, if taken together with the peculiar facilities offered for its successful founding, affords every assurance of large returns. The actual cost of works is entirely dependent upon its desired magnitude. One pot and a few hoppers sufficed among northern men, who during certain seasons left their farms to engage in this industry. Works adapted to the manufacture of various potash salts, and producing an output of $100 per day, can be erected at a cost not exceeding $1000.

The products of such works would embrace the following: crude carbonate of potash, 10 cents per pound; caustic potash, 20 cents per pound; ferrocyanide of potash, 40 cents per pound; Prussian blue, 60 cents per pound. These products are staple goods; the demand is constant, as but few arts and manufactures do not consume large quantities. Fuel is so plentiful that it can be had for cutting and hauling.

Pearls.—Pearls are small bodies found within the shells of the pearl oyster and a fresh water species of mussel. They are caused by disease, a parasite or the presence of foreign

matter. Pearls consist of carbonate of lime and organic matter, and are not always pearly throughout, a small hole or nucleus are invariably present. If round; of good color; and fine lustre, are very valuable, the value increasing rapidly with that in size. The finest white pearls come from India, Persian gulf and Panama; black and grey from lower California. Several fine, large pearls have been submitted me for examination, the owners having found them in the White and Buffalo Rivers, in the former of which streams the author has also found them in the common mussel. The systematic hunting for these gems would certainly prove profitable.

Pyrites of Iron.—Sulphide of iron. Color, brass to gold—yellow. Hardness, 6. With steel strikes fire; rubbed on a white stone gives a brownish black mark; brittle. Occurs in many forms; here only; massive or disseminated, in ores and rocks. A valued source of sulphuric acid, copperas and mineral paints. In some places, also, as a source of sulphur, sometimes contains gold. But two or three deposits of such extent as to justify working occur in this region; the accessibility to navigation, character and extent of deposit, abundance of fuel, etc., offers unexcelled facilities for the founding of a profitable in-industry.

Guano.—In caverns, similar to those written of in treating of nitre, occur enormous deposits of guano. This guano is the droppings of the innumerable bats, which have for centuries inhabited these caves. Incorporated with it is the remains of animals and other organic matter. In richness of fertilizing elements it is superior to the best Peruvian guano shipped to this country; containing a larger percentage of available nitrates, phosphates and ammonia. The cost of mining will not exceed 50 cents per ton. A market offers in the plantations of Louisiana, and to the manufacturer of ammonia, a profitable industry.

Mineral Paints.—Available to use in the manufacture of mineral paints. The region affords deposits of ochre and umber; the residue from nitre manufacture; that from the burning of iron pyrites, numerous iron ores, lead, copper and zinc.

Facilities for Smelting Ores.—No facilities for the smelting of their ores, is available to the miners of the region other than those offered by the very limited capacity of the author's sampling works, the capacity (daily) of which is limited to the reduction of 800 pounds of lead ore; or 400 pounds of copper ore; or 100 pounds of zinc ore. Increased capacity will shortly be given these works, by putting in operation "for the reduction of zinc ore," the author's process of lixiviation, by which means better facilities will be afforded the miner, still not such as the region requires and the welfare of the miner demands. An unexcelled field offers here for the erection of reduction plants, using wood or charcoal as fuel. The enormous water power available renders the location peculiarly well adapted to the requirements of an electric smelting plant. The character and quality of the ores, their accessibility and low cost, cheapness of transportation, fuel, labor and desirable sites, are among the advantages the region offers to such industry. In the absence of adequate local ore markets it is difficult to estimate the probable output of ore. Suffice it to say that some four or more properties are sufficiently well developed to supply two or more smelters for years to come.

Ore Crushers.—Several choice locations offer in this region for the establishment of small custom crushers; such completed, need not exceed $1200 to $1500.

Local Markets.—The absence of local ore markets debars from mining those who are dependent upon the proceeds of each day's labor, and is the source of the seeming indifference of our people to mining operations.

Railroads.—The outlook is very promising. Several surveys traverse the region in various directions and construction work on one began. A company recently organized has in hand the construction of a road from Springfield, Mo., to Sabine Pass, Tex., which, if built, will pass through this region and give us access to the coal fields near Little Rock. Batesville, "on White River," West Plains and Springfield, Mo., and Eureka Springs, Ark., are now our nearest railroad points,

the distance to any one of which is seventy-five to one hundred miles.

Timber.—For mining purposes and tramway construction is abundant and accessible.

PROGRESS IN METALLURGY.

The past twenty years has been remarkable for the wonderful achievments in all branches of industry. This period has been characterized by boldness of design, brilliant conceptions of and practical embodiment of ideas that heretofore seemed visionary and the offspring of folly. The sweeping aside of the supposed boundary lines, that in ignorance, was esteemed to encircle all things attainable to man, has opened up to inventive genius, fields vast and fruitful, whose boundaries are fixed by God himself in the outer limits of space. Each discovery that is made, whereby the apparent power of the earth, to afford sustenance to population is increased, is but a manifestation of the wisdom of the Creator, who has so provided it that so long as he wills that time should last, so long the earth can support and sustain the lives of those upon it. In time of necessity, the idea comes, as also the man to embody it. He opens and nature yields to him the treasures of her vaults, and increase in prosperity follows. In few industries has advance been more radical than in the arts of metallurgy. Startling innovations, have, with unexampled rapidity, been introduced to the setting aside of old methods of procedure and the cumbersome appliances which had found use for centuries. Durability, simplicity, economy and portability, combined with rapidity of action has been the desiderata, and has culminated in the Eureka portable smelting furnace, which in size ranges from one hundred pounds to as many tons as desired and is indicative of the capacity. The simplicity of construction and durability of parts, renders it within the powers of any to make requisite repairs. The perfection of its adaptability may be seen in that, a blacksmith can, by the use of aluminum alloy composite, with the smaller sized furnace, which he can carry, make ninety to one hundred and twenty

pounds of malleable steel castings every half hour. The gold, silver, copper, lead or zinc miner, can, however, remote and inaccessible, his mine may be, readily, by means of this furnace, put the product of his mines into a marketable form, of such nature as to bear heavy transportation charges, and so enable him to effect the development of his mine. The furnace can, in a few minutes, be changed from a capula to a crucible furnace, in which it is adapted to the reduction of zinc, antimony, or other volatile ores. In the reduction of other ores the process is continuous, and the daily output of metal from the smaller sizes will aggregate 600 to 1000 pounds. It is a furnace of this description that is used by the author in his sampling works for the smelting of lead and copper ores, and the distillation of zinc. It can there be seen in operation almost daily, as it is now the only smelting facility offered the miners of the region. This furnace is the invention of Mr. C. H. Hartsfeldt (the energetic and progressive president and manager of the Hartsfeldt Furnace and Reduction Company, of Newport, Ky.), who is also the inventor of an electric furnace for the smelting of ores and the reduction of aluminum, direct from aluminum clays, and the fabrication of aluminum and nickel alloys, for use in increasing the fluidity of metals and the securance of smooth malleable steel or iron castings.

GEOGONY OF DYKES, ORE VEINS AND FISSURES.

[NOTE.—First written as one of a series of lectures, for one of the author's classes in mining geology.]

Primitive rocks are those whose period of formation is considered as antecedent to that of the creation of organic beings. The members of this division occur in both the stratified and unstratified condition, and all rest upon a foundation of granite, the lowermost of all known rocks. The primitive position of the overlaying beds, or sedimentary deposits, was that of horizontal layers, and such position may be retained, or may have, through the action of subterranean forces, been so altered that

the stratas are found inclining from the horizontal at various degrees.

Such alteration or change of position may with propriety be regarded as the primitive result of the action of such interi r, deep-seated forces as, secondary to it, in order of sequence, is first, the bursting asunder, along the lines of least resistance, of the various stratas comprising the formation subjected to disturbance; and second, the consequent opening up of rents and fissures, with their attendant systems of lesser ones; and third, the filling in of the fissures, so effected, with matter, molten or plastic, injected from lower depths.

The alterations effected in the character of the members of a formation in contact with such intrusive matter, are greater, more radical and widely extended, than those effected in position, but at present we will only consider such of these as can justly be regarded as characteristic of vein structure.

General Characteristics.—The rock adjacent to, and composing the formation traversed by a vein, is termed the country rock, and differs in character and kind from the structural matter of the vein (except when granite veins occur in a granite formation). The rock, which bounds the wealth of the vein, is known as the wall rock. That which overhangs the vein matter, as the hanging wall, the lower as the foot wall. In regions where the dip is northward, the hanging wall is designated the north wall, the lower the south wall.

Where the walls and vein are in contact, there is usually found a seam, in thickness varying from that barely perceptible to one of a foot or more filled in with a soft, soapy-like earth of various colors (Talc). Such seam is known as selvage. It may be present at the juncture on both sides of the vein, or absent from one or both. It is rather a characteristic of the foot wall.

The upper or hanging wall, sometimes the lower also, where in contact with the vein, is found marked and grooved by striations and more or less polished. This appearance, resulting from the abrasion of surfaces through the passage of the vein

matter upward, is called slickensides, and the matter enclosed by the walls, the veinstone.

The direction traversed by a vein, is termed its strike or trend, and is determined by a compass. The inclination of a vein is the angle such inclination forms with the horizon, and is found by use of a quadrant or clinometer.

The dip of a vein is the direction of the inclination, and is always at right angles to the strike.

In length, the variation of veins is very great, some extending but a short distance only, while others can be traced for miles. In width, the variation is scarcely less great, some occurring in width no greater than the thickness of paper, others again having a width of many feet. Where the intrusive matter is from below, the depth is unknown. The course of veins are more frequently than not, indicated by detached and more or less decomposed portions of the vein matter, together with depressions of sinks, termed blowouts, and masses of vein matter elevated above the surface, known as chimneys.

Veins are divided into two classes, viz.: Dikes and veins proper. In the former the walls are parallel, the width and direction constant, and the containditure known volcanic rocks, as trachyte, trap or basalt, arranged in massive forms with a more or less perfect transverse fracture, through which, by weathering, an appearance of a transverse column or structure is afforded. The intrusive matter is regardless of kind the same thoroughout.

The latter, on the contrary, are distinguished by numerous small veins (feeders) entering at various angles from a given course. The presence of marked expansions and contractions in width throughout its length, variation in course, faultings, interruptions and the presence of enclosures of country rock (known as horses), and that as depth is attained, there is an increase in width. And also, that the vein matter is not of trappean origin, and is composed of several matters. Further, the selvage of dikes is earthy or of laminated structure, arranged parallel to the walls. Dikes are sometimes metallifer-

ous, when so, the ores are in immediate contact with the wall or found penetrating its substance.

A vein may or may not be metalliferous. If the former, it is termed a lead or lode, and the vein matter inclosing the ores or metals, the matrix, gangue, or veinstone, and the apex, or that part visible above ground, the outcrop. Fragments of ore, or of a known metalliferous rock, are known as float. Through the presence or absence of exterior features indicative of their presence, leads or lodes are subdivided into two classes, both agreeing in all respects, except that in the one instance, either through not reaching the surface, or being covered by a formation of later date, or the material brought down by a mountain slide, the one gives no visible evidence of its existence; such are designated as blind leads or lodes.

The foregoing are the true fissure and contact veins of the miner, and are so called in contradistinction to those formed by the overflow of vein matter entering fissures opening downward, being widest at the surface and narrowing as depth is attained, and of limited extent; such, are false fissures.

Veinstones.—The vein matter commonest to, and forming the matrix of, the ores; of this vein system are quartz, granite, feldspar, porphyry, calc-spar, baryta and fluor-spar.

Associated Ores.—Quartz is, *par excellence*, the first of vein stones, there seeming to be a peculiar affinity existing between this substance and metals and their ores. Gold, platina, silver and bismuth are common to it in native form. Also, the ores of silver, copper, nickel, cobalt, tin, antimony, lead, zinc, pyrites of iron (usually auriferous), iron and manganese ores, usually in small quantity in the upper portions of the vein and are generally argentiferous or auriferous.

Granite as a vein stone; is characterized by the occurrence of greater deposits of tin ore than is found in any other vein stone—opal, topaz, beryl, rock crystal, corundum and magnetic iron ore, and pyrites of iron are of common occurrence.

Feld spar, occurs as a vein stone of many veins, few of which have proved productive of ores in quantity; sulphide of copper, of lead and iron being commonest.

Porphyry, as a vein-stone for productiveness of ores, both in kind and quantity, is scarcely inferior to quartz.

The spars, pearl "satin" and calc spar, are found associated most frequently with the ores of zinc and lead in the order named, and these, together with baryta and fluor-spar, are found as the matrix of ores of silver, mercury, copper, cobalt, nickel, arsenic. Lead and zinc, mineralized by carbonic acid, arsenic, selenium, sulphur, tellurium, chlorine, iodine and bromine, in supposed igneous veins, which we will consider under a separate division,

Distribution of Ores.—The ore containditure of veins are variously arranged. They may occur disseminated throughout certain portions of the matrix or gangue, in scales, wires, platy pieces, shots, spangles, nuggets, in crystals of various forms, or in extensive compact masses; also, in reniform and other shaped forms, arranged in layers or in other manner, separated by more or less extensive portions of barren vein stone, no vein being metalliferous throughout its extent.

Structure of Veins.—Comparatively few minerals enter into the structure "of some veins," and these are massive and intimately aggregated together. Other veins, again, are composed of various minerals, which show but little regularity of structure or arrangement of parts. Openings more or less extensive are found filled in with earth or as druses of crystals of quartz, or with water.

Chemistry of Veins.—The contact "more or less intimate" of the various differing constituents of the veinstone, and the more greatly varied ones of its metalliferous enclosures in the presence of moisture introduced from above, through the media of the selvage matter, is productive of a series of chemical actions and reactions, and the generation of galvanic or electric forces, through the combined agency of which, radical alterations are effected in the character of the veinstone, the species of ores and their mode of arrangement. The results of such actions are most evident in the upper parts of the veins and in those portions nearest in contact with the walls.

Exterior Indications of the Presence of Veins—When a vein has reached the surface, its direction is either wholly or in part outlined by fragments of the veinstone along its direction. Such fragments are derived from the disintegration of the veinstone by atmospheric agencies. Such ores or metals as may have been enclosed are freed, "in part, at least," and either retain the primitive form, or undergo a change of form, more or less "under both circumstances" remaining *in situ.* The exposed portions of the vein is its outcrop. Erratic fragments of its rock or ore found on the hillside, or in the valley ore known as float.

Colored stains "of metallic oxides" occur in and on the adjacent earth, rocks and often on the stems and leaves of plants. Such stains determine the metalliferous character of the vein, and further are indicative of the nature of its contents, as various shades of green are due to the presence of nickel, copper, iron, the latter a combination with organic acids. Those of red, to that of iron, lead, mercury. Those of yellow, to that of iron, antimony and lead. Those of black, to that of manganese, iron, sometimes copper. Combinations of these stains are, of course, deceptive. A number of ores, especially those of iron, occur with tarnishes variegated and of metallic lustre. Such result from the iron being in combination with an organic acid and are disregarded.

Prospecting, (*i. e.*, a hunting for mineral deposits.)—As is evident, to be successful in the hunt necessitates the following, viz.: To know where to look, when to look, what to look for and to *know the thing when found.* Many dollars and much labor has been spent needlessly in all mining regions in working something of SUPPOSED value. The instructions given which have reference only to the occurrences of this region, will, if fully utilized, enable one to prospect to some advantage. Selecting your field of operation you will begin at the lower end of a gulch or valley. Directing your step toward its source you will carefully observe each rock or boulder passed, bearing in mind that the outer weathered surface of the rock is no index of its character. You will break off fragments by

which to determine its color, texture, weight, method of cleavage, etc. On finding a fragment of ore, or of a mineral-bearing rock, you will proceed to trace it to its source, the deposit. Such deposit may be at the head of the valley or at any elevation on the mountain to your right or left. To effect its location proceed as before until that point is attained above which you can find no more float. Should the formation of one side of the valley be such as to preclude the possibility of ore or rock rolling from it, you know that the source of supply must be the other side. You now, from the place at which the last float was found, ascend the mountain, zig-zagging across its face, carefully examining each rock, earth or stain observed, remembering that a few inches of earth, leaves, moss or sticks may effectually conceal the deposit from your sight; also, that the outcrop or exposure of ore may not exceed in size an inch or two. Usually, you will find unmistakable evidences of the presence of the deposit as you approach. Should you be unsuccessful on one side try the other. If, in your ascent of the mountain, you reach a point above which no float is observed, cross cut a few feet above the point where float was last observed, and in general, the deposit will be found. Once knowing the ore-bearing stratas, you can confine your operations to them, following their exposures. In so doing, where the vein stone is deeply eroded, disintegrated, you will find float abundant; from which along the pathway of this float, you will examine for the presence of local faults, sinks and crevices, any of which may have formed the receptacle of the eroded ores and now be an extensive deposit. A very small outcrop of ore may be the visible evidence of a very large deposit, and hence demands attention. In this region iron ore quite frequently is the only outcrop of zinc and lead ores. Such, together with erratic fragments of the ores themselves, and of the vein stone, form the guides of the prospector, who should, under no circumstances, cast aside an unknown mineral. Many rich ores to the eye afford no evidence of their nature; silver and gold may be present in paying quantities, yet not visible.

LOCATION OF CLAIMS.

On discovering a deposit of mineral on vacant "unclaimed" government land, you may secure such deposit by locating it in the manner as provided by the U. S. Mining Statutes, "the location notice being to all intents and purposes as good as a deed, so long as the law is complied with." In the location of the tract of land claimed by you, you will correctly as the means at your disposal admits of, measure each side of the claim, establishing each corner by blazing a tree on two sides facing the direction of the lines, and piling up a few rocks at its base, or by driving a stake. (Should you blaze out each line, you will do well, as such blazes indicate to all other prospectors that such land is claimed, and the completeness of your description will, "should adverse claims arise," protect your location and fix the ownership in you. Your location must conform with U. S. surveys. Where you made the discovery of mineral, you will post in a conspicious place a notice. For form, see convenient forms.)

A copy of this notice is recorded with the County Clerk. "In the absence of an organized mining district," where such is existant, then with the recorder of the district. Greater safety and escape from annoyance may be had by recording with both officials. See that no mistakes occur, as your ownership is greatly dependent upon the perfection of your description of the land claimed. Not more than 160 acres can be held under cover of a single location, notice but as many locations may be made, as the extent of vacant land admits, and the locator desires. A claim is twenty acres, and is located in one name, each additional twenty acres requiring an additional name, eight names being requisite in the location of a claim of 160 acres. After the location of your claim, you have until the 1st of January next, succeeding the date of location (unless such date be January 1st), in which to perform your annual assessment work, viz., $100 which may be spent in opening a road, building a house, digging a well, etc. "*Provided*, such is necessitated for the proper working of the claim," opening up the ore de-

posits, etc., etc. After the doing of $500 worth of development (whether in one or in five years), you can obtain patent "for method of procedure, see U. S. Mining Statutes.") The most extensive and desirable ore deposits occur in greatest numbers upon lands so located and held, for the reason that prior to our people becoming acquainted with the value of ores, they selected for homesteading such lands as were most valuable for agricultural purposes, and as but a very few acres of tillable land occurs in association with the ore deposits, which in general are found in streams, bluffs, ravines, and on the sides of steep mountains, such lands were not then desired and have since been withdrawn from homestead entry.

EQUIPMENT OF PROSPECTORS.

As in prospecting, your field of operations will lie in the rockiest, roughest and most broken mountainous portions, some danger is attendant upon your efforts through the chance misstep, rolling rocks, etc. It is therefore best and safest for two prospectors to work in company A light poll pick, a light round-pointed shovel, a small stone hammer (chisel-shaped at both ends), a hatchet, a small magnifying glass, a compass, a pouch "for specimens," and a leather belt (supported by a shoulder-strap), to which the hammer, hatchet, pouch, etc., may be hung, completes the equipment, unless it be desired to explore caves, in which case, a coil of light, but strong rope, a bull's-eye lantern, a bottle of oil, a box of matches, and a ball of strong twine is added. The twine is called into use, where from the presence of numerous passages, doubts as to that leading to the open air may arise. In entering a cavern, on reaching such a place, never neglect fastening an end of the twine securely to a rock in the main passage, then permitting the twine to play out as you go, you lay a safe guide by which to retrace your steps, or by which others might find you, should accidents happen. It is also well to leave a token of your presence at the entrance of the cave. A woolen shirt should be worn, ducking or denims should clothe the lower limbs, and leather leggings "reaching

to or above the knee," be worn as protection to clothing, and from a chance snakebite.

ORES—METHOD OF OCCURRENCE.

[Note.—The following will be found of assistance in fixing the character of the mine and in directing its working:]

Metallic ores exist in four ways. 1st. In irregular masses. 2d. In fissures or veins crossing the strata, filled with ores enclosed in some matrix. 3d. In regular interstratified beds or layers. 4th. Intermixed in small fragments among rocks.

OCCURRENCE OF ORE DEPOSITS.

Silver occurs in primary and transition rocks, as quartz, porphry, syenite, lower sandstone and sometimes in coal beds.

Gold, as above, abundantly in the sands of some rivers.

Platinum, osmium, iridium, rhodium and pallidaum almost invariably associated. Occurs almost wholly in the sands of rivers.

Mercury occurs in slate, limestone and coal strata.

Copper occurs in primary and transition rocks; also sometimes in magnesian limestone and sandstone.

Iron occurs in all formations.

Tin occurs in granite, gneiss, mica-slate and in alluvial deposits.

Antimony occurs in transition and secondary rocks.

Zinc and lead occurs in primary transition rocks (except trap and serpentine), stratified magnesian limestone. The rocks here named are those encountered by the miner in the mining of ores.

Number of Cubic Feet Removed from an Excavation.

Loose earth	24.	Earth with gravel	17.8
Clay	18.6	Clay with gravel	14.4
Coarse sand	18.6	Soil (common)	15.6

The volume of earth and sand in place exceeds that in the embankment in the following proportions: Sand, 1–7; clay, 1–9; gravel, 1–11; rock in large fragments, $\frac{1}{2}$–1.

List of Tools adequate to the requirements of a working force

of four to six men; ample provision is made for breakage, wear, etc.: Three sets of drills of 5 drills each, of the following lengths, cut from 1⅛-inch octagon steel bars. Each drill must be bitted to follow the cut of the lead drill; 2, 18-inch lead drills; 10, 36-inch followers; 2; 60-inch followers; "these last will be but little used;" 2, 36-inch and 1, 60-inch iron spoons and tamping bars; 6, 12-inch 1x1 soft steel gads, 3, 6-pound striking hammers, 2, 14 pound rock hammers, 2, 6-foot crowbars, 6 poll picks, 4 double pointed picks (miner's). ("NOTE.—It is very difficult to carry down the walls of drift, cut, as shaft, with the straight common railroad picks.") Four short-handed, round-pointed shovels, 3 long-handled shovels, 2 iron-wheeled wheelbarrows; 1 pair crimpers for "crimping caps around fuse;" dynamite, fuse and caps in sufficient quantity.

The following also is required for above force, but need not be increased for a force ten times its size:

One small portable forge, 1, 75-pound anvil, 2, 2-pound blacksmith hammers, 3 pairs tongs, 1 Hardy, 1 cut-off, 1 cold chisel, 4, 18-inch files, 1 set 8-inch car wheels, 1 rip saw, 1 crosscut saw, 1, 2-inch, 1, 1-inch, 1, ¾-inch and 1, ½-inch bits and augurs, 1 hatchet, hammer, 1 broadaxe, 4 axes, 1, 6-foot crosscut saw, 100 feet 1¼-inch rope, 1 tape line (50 feet), 1 carpenter's square.

Table of Specific Gravities.—By means of this table and a tape line the contents of ore dumps, etc., can be closely approximated, due allowance being made for foreign matters present:

Quartz.....	weighs	162	lbs.	to	the	cubic	foot;	12.34	cubic	feet,	1	ton
Chalcopyrite.	"	262	"	"	"	"	"	7.63	"	"	1	"
Pyrite	"	312	"	"	"	"	"	6.41	"	"	1	"
Galena	"	461	"	"	"	"	"	4.34	"	"	1	"
Black Jack ..	"	449	"	"	"	"	"	4.08	"	"	1	"
Limestone...	"	174	"	"	"	"	"	11.50	"	"	1	"

LEGAL FORMS.

[Form 1.] Miner's Lien.

Know all men by these presents: That I, ..., of the County of....., State of..... do hereby give notice of my intention to hold and claim a lien, by virtue of the statute in such cases made and provided, upon .....[describe premises]....., with all improvements and appurtenances, situated in ..... mining district, County of ...., State of .....

Said lien being claimed and held for and on account of work and labor done by me, as ....., for ....., owner of said premises, from the .... day of ....., A. D. 189.., to the .... day of ....., A. D. 189..

The total value of the said work and labor being ..... dollars, upon which there has been paid the sum of ..... dollars, leaving a balance of ..... dollars still due, owing and unpaid, to me, the said claimant.

....[signature].

State of ....., County of ....., ss.

On this ..... day of ....., A. D. 189.., personally appeared before me, the above named ... ., who, being by me first duly sworn, on .... oath states that the above abstract of indebtedness, mentioned and described in the foregoing notice, is true and correct, and that there is still due and owing to ..... from the said ....., for the ..... aforesaid, the sum of ..... dollars and .... cents.

.....[signature].

Subscribed and sworn to before me, this ..... day of ....., A. D. 189..

.....[official signature].

Note.—For materials, insert "for goods furnished and delivered to owners of said premises, for use on said premises, and which were used on said premises." Below "materials furnished, to-wit, powder, lumber, etc., as per bill annexed," in place of "work and labor."

[Form 2.] POWER OF ATTORNEY TO LOCATE AND SELL.

Know all men by these presents: That we, the undersigned, ...[names].... citizens of the United States, have made, constituted and appointed A. B., [some third person, who will locate and stake,] our true and lawful attorney, for us and in our names, to locate, stake and record for us, each lode, claims and placer mining ground, in the State of ....., County of ....., and, having located the same, to bargain, sell, grant, release and convey the same, entire or in separate parcels, to make proper deeds, seal, acknowledge and deliver the same, to such persons as our attorney may desire; hereby ratifying and confirming all lawful acts done by our said attorney by virtue hereof.

Witness our hands and seals, this .... day of ...., 189..

.....[names.]

State of ....., County of ....., ss.

On this .... day of ....., A. D., 189.., before me, ... in and for the county and State aforesaid, appeared ...., personally known to me as the persons whose names are subscribed to the foregoing power of attorney, and acknowledged the execution thereof as their free act and deed, for the purposes therein mentioned.

Given under my hand and seal, the day and year above written.

.....

OPTION.

For and in consideration of the sum of ..... dollars, to me in hand paid, the receipt of which is hereby acknowledged, and the undertaking of ..... to pay ..... the sum of .....dollars on or before the .... day of ....., 189...., hereby grant, bargain, sell and convey unto the said ...., and to his heirs, successors and assigns, upon the consideration hereinafter written, the following described land, situated in ..... County, State of Arkansas, to-wit: [Here insert description of land.] If said ..... shall fail to

pay the sum hereinbefore named within the times set forth, this conveyance shall be void and all rights and liabilities of either party thereunder shall cease, and said land shall revert to ..... without any reconveyance from the said ....., And I, ..., wife of ....., hereby release and relinquish unto said grantee all my right of dower in said lands.

Witness our hands this .... day of ....., 189...

[Acknowledgment and jurat.]

.....

Quit-claim Deed

Know all men by these presents, That we ....., and ....., his wife, in consideration of the sum of ..... dollars, to ..... paid by ..... do hereby grant, sell and quitclaim unto the said ..... and unto his heirs and assigns forever, the following lands lying in the County of ....., and State of Arkansas, to-wit: [Describe property here.] To have and to hold the same unto the said ..... and unto his heirs and assigns forever with all appurtenances thereto belonging, ..., and I, ..., wife of the said....., for and in consideration of the said sum of money, do hereby release and velinquish unto the said ....., all my right of dower in and to said lands.

Witness our hands and seal this .... day of ....., 189...

JURAT. .....[SEAL.]

.....

.....

Mineral Location Notice.

State of Arkansas, }
County of..... } The.....Mining District

Notice is hereby given that I, ... citizen of the United States, hereby, on this.....day of.....189.., locate and claim as placer ground, in virtue of discovery, and by compliance with requirements of the United States mining laws, and the local rules and regulatious of the district, the

following described mineral lands, for the purpose of mining the ores of copper, zinc, lead and such others as may be found thereon. The name of this mine is the .....

And is described as follows, to wit.: From this location notice at point of discovery..... (Here describe the land, its boundaries, etc.) Including all parallel veins, beds or other deposits of ores of whatsoever nature, within said boundaries, the same being situated in section....., Tp....., Rn..... ..., County of ....., State of Arkansas. All persons are cautioned, under the penalty of the law, not to cut timber, or remove ores, or otherwise trespass upon said property.

Witnesses..... Locator..... .....

Form of Acknowledgment.

State of.....
County of..... } ss.

I,.....a Notary Public in and for said County of....., in the State aforesaid, do hereby certify that.....personally known to me to be the person whose name is subscribed to the annexed deed, appeared before me this day in person, and acknowledged that he signed, sealed and delivered the said instrument of writing, as his free and voluntary act, for the uses and purposes therein set forth.

Given under my hand and official seal, this....., day of .....A. D. 189.. .....

Term expires..... Notary Public.

Escrow Agreement.

Where a deed is made in escrow the deed is enclosed in a sealed envelope and placed in the hands of some responsible party for safe-keeping, who will, on the fulfillment of the following agreement written upon the envelope, make delivery of the deed:

FORM OF AGREEMENT TO BE WRITTEN ON ENVELOPE.

The enclosed deed of the ..... lode or mine is hereby placed in the hands of (person or bank) of ..... in escrow. If ..... shall place or cause to be placed to the credit of ..... and ..... in the said (person or bank) on or before the .... day of...., 189.., the full sum of..... dollars, then and in that case the said (person or bank) is hereby authorized to deliver the enclosed deed to ..... or his order. In case the said .... shall not place or cause to be placed to the credit of the said ..... and .... in said (bank or person) the full sum of..... dollars on or before ...., 189.., then the said bank is hereby authorized to deliver the enclosed deed to the said ..... and ..... or their joint order. Sign with three names, give place and date.

PROOF OF LABOR.

State of Arkansas, }
County of..... } ss.

Before me the, subscriber, personally appeared....., who being duly sworn, says that at least ..... dollars' worth of labor or improvements were performed or made upon ..... situated, ... mining district, County of ....., State of ....., during the year ending ....., 189.. Such expenditure was made by or at the expense of ....., owners of said claim, for the purpose of holding said claim.

[Seal.] .....

This Agreement, Made and entered into this .... day of ....., A. D. one thousand eight hundred and ..... by and between ....., of the County of ....., State of ....., and ....., of the County of ....., State of ..... of the second part:

Witnesseth, That for the consideration of the sum of .... dollars, in hand paid by the said party of the second part, to the party of the first part, the receipt of which is hereby acknowl-

edged by the said party of the first part; and in consideration of the further covenents, agreements and stipulations, hereinafter mentioned, on the part of the said party of the second part, the said party of the first part hereby leases unto the said party of the second part..... heirs and assigns all the *lead, zinc and other minerals*, in, under, or upon the following described tract or parcel of land, being situated in township .... range ...., County of ....., and State of .... ., and bounded and described as follows, to-wit: ..... And the said party of the first part, also, hereby further give, grant and convey unto the said party of the second part.... heirs and assigns, as well as ..... workmen and laborers, the right, privilege and license to enter upon the above described land at any and all times hereafter, and search and explore thereon for said *lead, zinc and other minerals*, and when found to exist on said land, to dig, mine and remove the same therefrom, together with all, and singular, the rights, privileges, licenses and easements, necessary or incident, or in any wise necessary or appertaining to the proper prosecution of the business of mining and removing said lead, zinc and other minerals, and also the right of way for all necessary roads and railroads over any portion of said land, and the right to erect thereon all necessary structures, buildings and fixtures of every kind necessary in the prosecution of said business, and the right to occupy a sufficient area of the surface of said land for stock and storing the said *lead, zinc and other minerals*, or other substances, and the refuse therefrom; and the right to use such timber as is requisite in the aforesaid business, and the right to remove and transport the lead, zinc and other minerals from other lands, over or under the land above described during the continuance of this agreement, and the right to remove and transport all tools, machines and appurtenances thereto belonging to said business.

For and in consideration of which, The said party of the second part hereby agree and bind ..... heirs, executors and assigns, to enter upon said land within ..... from the date thereof, and make search and exploration thereon for said *lead*

zinc and other minerals, unless satisfied, from examination of lands adjoining, or in the vicinity, that such exploration will be fruitless; and if the same be found to exist thereon in sufficient quantities and under such circumstances as to warrant the said party of the second part, ... heirs or assigns in digging, mining and removing the same, then, and in that case, the said party of the second part agree and bind .... heirs, legal representatives and assigns to pay the said party of the first part, ... heirs, legal representatives or assigns, the sum of ..... mined and remove from said lands, as *lead, zinc and other minerals*, according to the bills of the diggers; but not to include slack, fine coal or float ores, which said party of the second part is to have the privilege of removing and selling free of charge.

It is also further agreed by the parties hereto, for themselves, their legal representative and assigns that.... per cent. of all royalty due shall be paid the first of each month and the remainder at the expiration of each and every quarter, counting from the .... day of ....., 189...

It is also agreed that the correctness of the scales and weighing of said lead, zinc and other minerals, and the books showing the weight of lead, zinc and other minerals mined, shall be open at all times during business hours, to the party of the first part, his agent, legal representative or assigns.

In Testimony Whereof, The parties hereto have set their hands and affixed their seals the day and year first above written.

Signed, sealed, acknowledged and
delivered in presence of

....[SEAL.]

.....[SEAL.]

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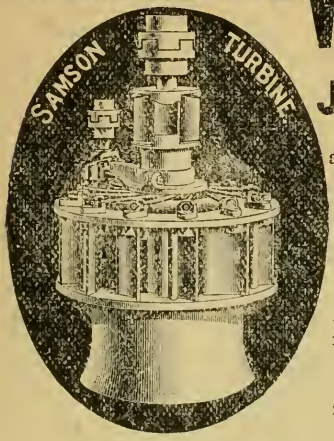

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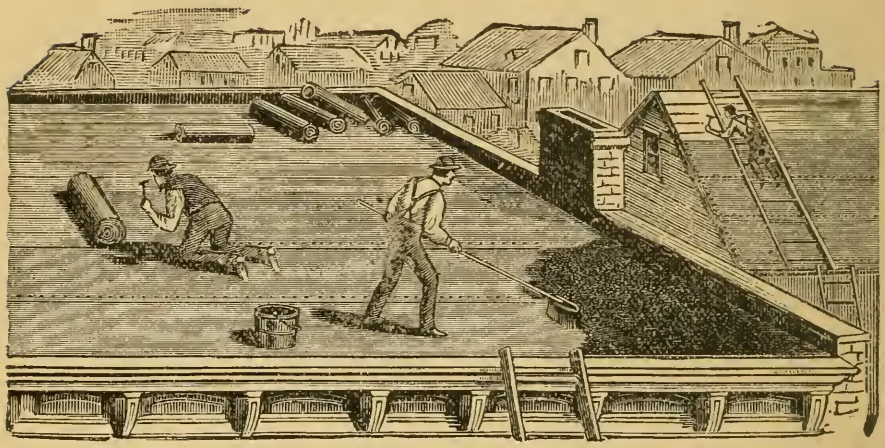

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